THULE PLANT AND DRIFTWOOD USE AT CAPE ESPENBERG, ALASKA

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A

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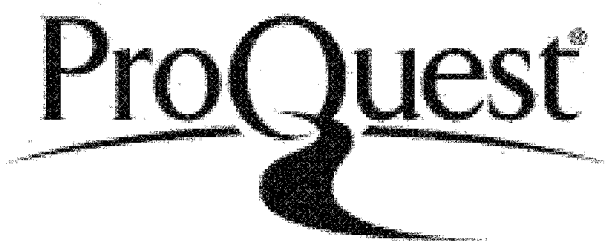

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Abstract

This thesis addresses the question of Thule plant and woody fuel use at Cape Espenberg, Alaska between approximately AD 1500 and 1700. The objective of this thesis is to determine how the Thule at Cape Espenberg were using various plant species, including edible plant species and fuelwood species. Few studies have been done on prehistoric Arctic plant use, and so this study intends to add to this nascent but growing field. By examining charcoal and macrofossil remains, this thesis is also intended to discover similarities and differences between the Thule and their modern Inupiat descendants in terms of plant and woody fuel use. Statistical tests and descriptive analyses indicate that plant foods contributed significant nutrition to the Thule diet at Cape Espenberg, that woody fuel was used heavily, and also actively conserved with the incorporation of alternative fuel sources such as bone and blubber. This exploratory study underscores the importance of plants in prehistoric Arctic economies, and the need for future research.

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Chapter 1: Plants and Thule People

Archaeological inquiries into Arctic prehistoric plant use are nascent. Only a small number of studies have focused on the interaction between far northern peoples and plants (Zutter 2009; Schweingruber 1977; Bocher and Fredskild 1993; Deal 2005 – among others). The role of plants in Arctic subsistence economies is often dismissed because plant biodiversity declines with latitude (Pielou 1994: 84; Lepofsky et. al. 2001: 50). This relative lack of diversity, however, does not mean that plant resources were an insignificant part of prehistoric north Alaskan economies (Lepofsky et. al. 2001: 50).

There is also a misconception that plant remains in archaeological contexts are often poorly preserved. On the contrary, plant preservation is often good in Arctic archaeological contexts due to the cool climate and the presence of permafrost. Furthermore, there are many areas in the Arctic and Subarctic regions that have abundant plant resources (Zutter 2009: 23) such as berries and other edible plants - as well as driftwood transported from boreal forests to northern shores. Archaeological investigation of floral remains and charcoal can enrich our understanding of subsistence economies, and provide direct evidence of fuel use and dietary practices (Johannessen 1988: 145).

Plant and wood resources have been important to Arctic peoples such as the Inupiat since the historic period, and undoubtedly much earlier as well. The Inupiat are the inhabitants of Alaska specifically, whereas the term Inuit refers more

generally to the native peoples of the Canadian Arctic and Greenland. Inupiat and Inuit people have relied on these resources for various purposes ranging from fuel, medicine, rituals, tools, bedding, containers, and housing, among many other applications (Zutter 2009: 23). Plant foods were also important in the traditional Inupiat and Inuit diet (Jones 2010; Zutter 2009; McIntosh 1999).

Admittedly, animal meats and fats provide the most of the calories in traditional Inuit diet – more specifically for this research, the Alaskan Inupiat diet. Plant foods provided only about 1-2% of the total calories consumed. The caloric contribution of plants may be negligible, but their nutritional contribution is significant. It has been estimated that upwards of 50% of the vitamin C consumed in a traditional Inupiat diet came from plants foods – as did the primary source of dietary fiber (Jones 2010: xvii).

Additionally, Burch (2006: 52) makes it clear that having a reliable source of fuel in a given location was just as critical as having enough food to survive the Arctic winter. For people living on Arctic coasts far removed from the treeline, driftwood was the main source of wood. For housing and tools, driftwood was an indispensable resource. Wood was used for fuel and other purposes such as steam baths only in locations where driftwood deposition is high, such as certain places in Alaska and the Western Arctic (Alix 2005: 84). The abundance of wood in various locations drives how wood is used. At Cape Espenberg, Alaska, (Figure 1.1) it is expected that wood was used for various purposes such as providing light and warmth, cooking food, and possibly for firing ceramics. A reliable and consistent

supply of driftwood would have been essential. It is expected that prehistoric peoples would have selected settlement locations partially on the basis of fuel and wood availability.

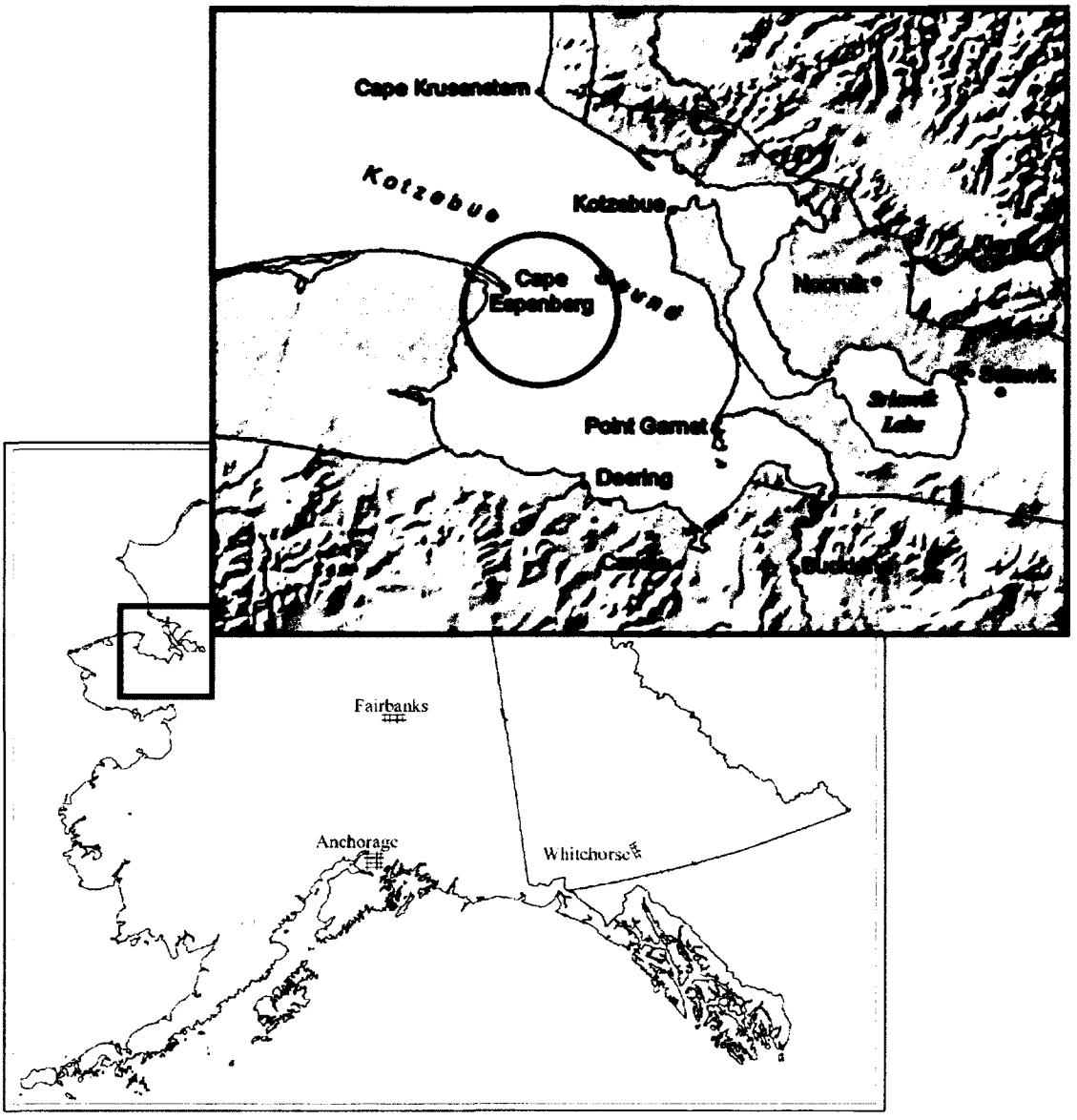


Figure 1.1: Location of Cape Espenberg (top map from NOAA).

The Thule culture belongs to the Neo-Eskimo tradition in Alaska that emerged sometime around 2000 years BP (before present) in the Bering Strait region (Arutyunov and Fitzhugh 1988; Mason 1998). The Thule culture is the youngest culture within the broader Neo-Eskimo tradition, and may have developed as early as 1000 years BP on St. Lawrence Island and/or in the Point Barrow region (Mason and Gerlach 1995b: 122; Staley 1994: 31, 84). Both archaeological and ethnographic data strongly suggest that Thule people were the immediate ancestors of modern day Inupiat and Inuit peoples. Indeed, there are a great number of similarities in material culture between the Thule and ethnographically known Inuit and Inupiat groups. Furthermore, the linguistic and cultural similarities across the Arctic make a strong case for the Thule origin of Inupiat and Inuit cultures stretching from Alaska to Greenland (Collins 1937: 375; Mathiassen 1927: 174-176, 184; Giddings and Anderson 1986: 91; Taylor 1963: 456).

Since plants were important to the historically known Inupiat in Alaska, it is expected that plants were similarly important to the prehistoric Thule. Perhaps the Thule used the same plants in the same way as the ethnographically known Inupiat. The degree of similarity between Thule and Inupiat plant usage has not been established. This thesis will address this question of behavioral similarities, but also broaden our knowledge about the Thule's subsistence economy.

Previous studies on Thule plant use have focused on wood, charcoal or on non-woody plant remains, always to the exclusion of the other. No study has yet analyzed both wood and plant macrofossil remains from within a single Thule site.

Furthermore, though studies on Thule and Paleo-Eskimo wood use have been conducted throughout the Arctic (Alix 2001, 2007, 2009a, 2009b), studies on other plant resources have mostly been undertaken in the Eastern Arctic (Zutter 2009; Deal 2005; Miller 1975). Studying both woody and non-woody plant remains in tandem can provide a more comprehensive representation of Thule plant use.

The main objective of this research is to determine how Thule people at Cape Espenberg in Northwestern Alaska used plants for fuel, food and other purposes. This research was accomplished through the sampling, identification and analysis of archaeologically recovered plant macrofossil and charcoal remains using methods and techniques developed by palaeoethnobotanists working in other regions (Hastorf 1999; Lennstrom and Hastorf 1995; Pearsall 1988; Zutter 2009; Johannessen 1988; Smart and Hoffman 1988 and others).

The macrofossil and charcoal remains analyzed in this study were sampled from two Thule-era houses excavated at Cape Espenberg in the summer of 2010, and from five of the off-site or off-house test pits excavated in the summer of 2011. The house features were excavated as part of a larger, interdisciplinary, NSF-funded project focused on the cultural and climatic history of the cape between *ca.* AD 1000 and 1700 – a time period considered critical in the development of the historic Inupiat culture (Hoffecker and Mason 2008: 2-3). Cape Espenberg was selected for the research conducted for this thesis in particular because organic preservation is good, and because it appears that wood was used heavily for fuel.

The main research questions of this study are as follows:

1. To identify plant taxa used by Thule from remains recovered from Thule house features
2. To explore the function(s) or archaeological meanings of these taxa by examining variability within features aided with ethnographic and modern data
3. To see if there are differences between the Thule occupations excavated at Cape Espenberg and other Thule sites in terms of plant and wood use, and if so, what explains this variability

Archaeobotanical research is important to Arctic archaeology not only because the vast majority of studies have been almost obsessively focused on the hunting of sea mammals, but because of its potential to provide fine-grained data about the lives of prehistoric peoples beyond the hunting aspect of subsistence. This data, although exploratory, can open up new avenues for studying prehistoric Arctic peoples. With further development, this research can provide information about seasonality, pre-historic environments, residential activity areas and perhaps even gender roles.

Although archaeobotanical research in the Arctic has only begun, its potential is great. Even this baseline data provides unique insights into prehistoric Thule subsistence practices in a way that faunal analyses cannot. Incorporating macrobotanical and anthracological research in combination with other avenues of exploration provides more comprehensive data than any one method could accomplish alone.

The Thule Culture

Early Thule cultural material can be difficult to firmly distinguish from earlier Punuk or Birnirk artifacts, and firmly ascribing sites to Thule as early as 1000 years BP is difficult (Mason 2009: 79) because of the similarities between the Thule and their cultural predecessors in Western Alaska and the Bering Strait. Due to commonalities in material culture, including but not limited to harpoon head design and architecture (Mason and Bowers 2009: 33; Anderson 1984: 92), it has long been theorized that the Thule culture probably emerged from the immediately antecedent Birnirk culture.

The Thule culture also shares traits with the Asiatic Punuk culture (Collins 1937: 372; Larsen and Rainey 1948: 170-175; Morrison 2001). Punuk designs have been found on Thule-era harpoon heads at Deering, Alaska. Evidence of Punuk influence also exists at the Kurigitavik site in harpoon head variability (Mason and Bowers 2009: 36, 29). These commonalities suggest that both the Birnirk and Punuk cultures somehow contributed to the genesis of Thule (Collins 1937: 363; Harritt 2004: 174). Although archaeologists argue about the degree of Punuk influence on the emergent Thule culture, the notion that the Punuk culture provided some Thule cultural elements is largely accepted (Anderson 1981; Dikov 2004; Harritt 2004). The Thule ultimately evolved into the historically known Inupiat and Inuit groups. This thesis only focuses on the Western Thule in northwestern Alaska.

As seen in Figure 1.2, Western Thule sites have been found along the coast at Point Hope, Cape Prince of Wales (at the Wales and Walakpa sites), Cape

Krusenstern, Cape Espenberg, and the Point Barrow region (the Point Barrow and Kirigitavik sites), and have also been found in the interior at Onion Portage, and at other sites along the Kobuk River (Giddings 1952; Anderson 1984: 91). The Thule people may have expanded as far south as the Alaska Peninsula, and perhaps even into the Brooks Range (Mason 2009: 79).

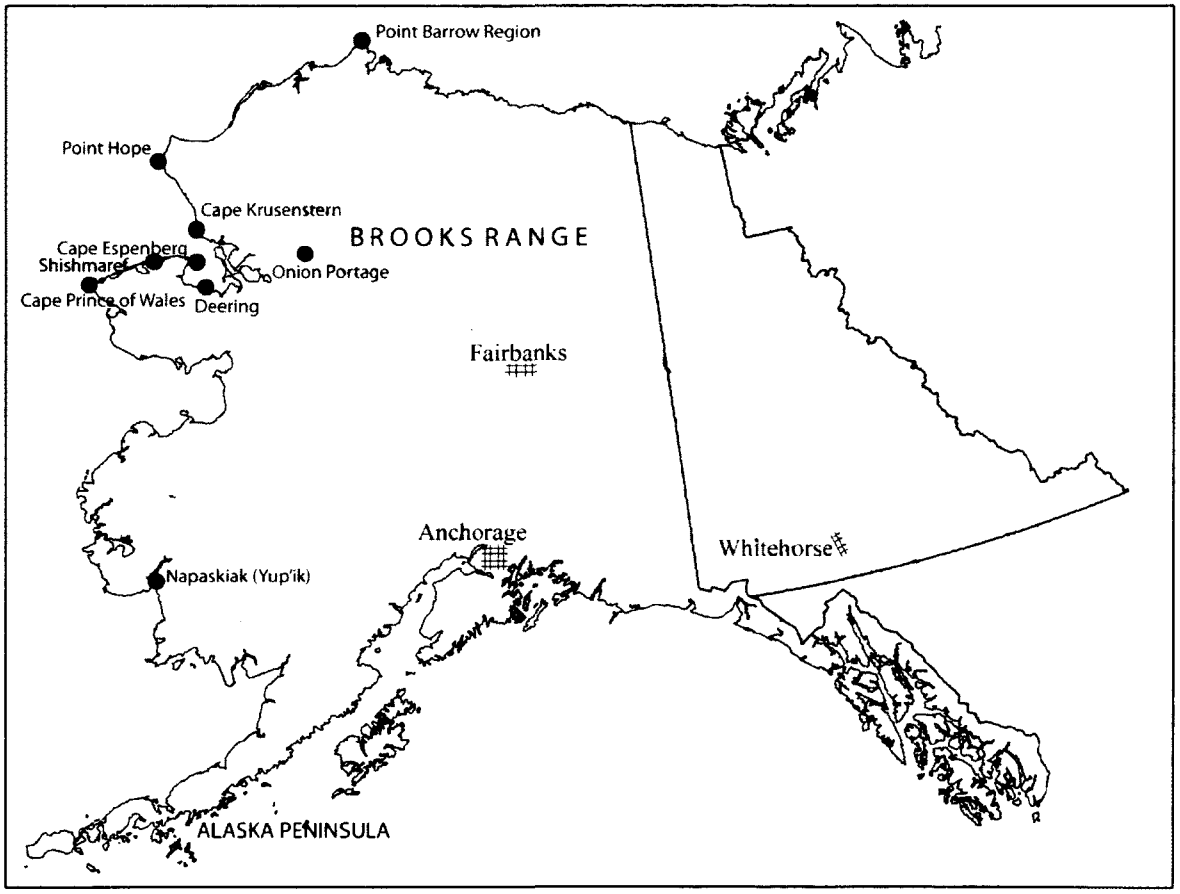


Figure 1.2: Location of selected Sites and Locations as Discussed in Text (adapted with permission from map by Nancy Bigelow, downloaded from NOAA).

At Cape Krusenstern there was an early Western Thule settlement from around 1150-700 BP, and a relatively large Late Western Thule settlement around

700-600 years BP (Giddings and Anderson 1986). Cape Krusenstern provides the most information about the Late Western Thule culture. The settlement may have been comprised of at least six Thule families, but probably more, as interpreted from the large houses (Giddings and Anderson 1986: 58, 70). The settlement pattern here appears to nucleate around a single important individual and his family.

Due to the discovery of what Giddings and Anderson (1986) interpret as whaling harpoons, the authors theorize that whaling was probably carried out at Cape Krusenstern, potentially lead by an important male individual, or *umelik*. The presence of possible public workrooms – perhaps a variant of the modern Inupiat *kazigi* – suggests the presence of an *umelik*, and attests to the development of an advanced hunter-gatherer society (Giddings and Anderson 1986: 110).

Thule settlements on the banks of the forested Kobuk River date back to at least 750 years BP, and perhaps earlier. The Thule here were not as heavily reliant on sea mammals like their relatives on the coast, but fished intensively for salmonids (Oswalt 1979: 228-229) hunted caribou, and traveled to the coasts for sealing only in the summer months (Anderson et. al. 1988: 18).

Thule technology was well adapted to Arctic environments and hunting sea mammals in open water (Morrison 2001: 74). Thule people preferred ground slate for everyday tools such as ulus, projectile inset blades, and slate knives or lance blades, although chipped stone blades continued to be used alongside ground slate implements (Dumond 1984: 101). Iron blades, however, were preferred when

available through trade (Friesen and Arnold 2008: 536; McGhee 1984a: 5). Thule sites often contain distinctive diagnostic artifacts such as Nunagiak and Thule 1, 2 and 3 harpoon heads, arrow points with tapering tangs, antler bone points, oil lamps, dolls, dog sleds (after 600 years BP), and brow bands and combs with inscribed cross-marked linear motifs. Decoration on Thule items is usually limited to a number of lines and occasional circles unlike the more elaborate decorations of previous Bering Strait cultures (Mason 2009: 79; Mason and Bowers 2009: 32).

Western Thule dwellings and architecture varied slightly from region to region. At Cape Krusenstern and other Thule sites, semi-subterranean sod houses with elaborate wood or whalebone construction are typical. Also common are sunken tunnel entryways and cold traps (Morrison 2001: 74; Dumond 1984: 101; Mason 2009: 79). At Onion Portage, houses have long entrance tunnels and deep living floors (Anderson 1988). Conversely, other houses have short tunnels with shallow floors (Anderson 1984: 92).

Most Thule houses were single-room dwellings, but some houses had multiple rooms (Anderson 1984: 92; Larsen and Rainey 1948; Mason 2009: 79). Large, multi-roomed architecture is unusual, but can be found at sites such as Utqiagvik at Point Barrow around 600 BP (Mason 2009: 79). At some sites, such as those at Cape Espenberg, the kitchen or hearth area is external, and appears not have been connected to the main house via the tunnel. At Cape Krusenstern, however, there does appear to be a connection between the house and hearth areas (Giddings and Anderson 1986).

The Thule culture is also defined by the manufacture and use of ceramics. Thule pottery is typically crude in appearance, thick and fragile, with a rough gravel temper (Mason and Bowers 2009: 32). In the central and northern areas of Alaska, Thule pottery is sometimes decorated with concentric circles, or spiral decorations made with wooden paddle presses in a style known as Barrow Curvilinear (Anderson et. al. 2011: 953). In the south of their territory, Thule pottery is sometimes inscribed with lines and dots (Anderson et. al. 2011: 953; Dumond 1984: 101). With only driftwood for firing their wares, limited clay sources, and a very short summer season in which to procure these supplies and fire their ceramics, the Thule ceramic industry would have had to involve complex, long-distance social interactions, and a high level of technological knowledge and skill (Anderson et. al. 2011; Frink and Harry 2008).

Western Thule technology such as harpoons and floats allowed for a varied diet (Anderson 1984: 92; Mason and Bowers 2009: 35). In favorable coastal areas Thule people hunted whales, and some larger settlements and communities may have been formed specifically to support this enterprise. Thule people also relied heavily on fish, waterfowl, caribou (*Rangifer tarandus*), seal, and smaller terrestrial animals such as arctic hares (*Lepus othus*) (Anderson 1984: 92; Dumond 1984: 103; Mason and Bowers 2009: 35).

During the Kotzebue Period, which roughly began around 600 BP, Thule subsistence shifted more heavily to hunting seals and fishing (Giddings and Anderson 1986: 56). Salmon harvesting intensified in the Kotzebue period possibly

because it became easier to haul catches with the innovation of the dog sled (Mason 2009: 79). At Cape Krusenstern, as well as at sites along the Kobuk River, Point Hope, and Point Barrow, archaeological evidence points to the importance of subsistence fishing and waterfowl hunting. Fish spears, leisters, multi-pronged arrows, and net sinkers bear testimony to these aspects of Kotzebue Period Thule subsistence (Giddings and Anderson 1986: 111).

During this period, whaling seems to have been abandoned in the Kotzebue Sound region. Whale populations also declined, and baleen whales ultimately disappeared from the region by the 19th century (Giddings and Anderson 1986: 113). Thus, without the need for large numbers of people to carry out whaling activities, and without this major food source, Kotzebue period settlements became smaller and more dispersed than they were during the classic Western Thule period which dates from around 1000 - 800 BP (Giddings and Anderson 1986: 113; Anderson 1972). A more broad-based subsistence strategy was adopted during the later Kotzebue Period (Harritt 1994: 55). Netting fish seems to have been especially important during this time (Giddings and Anderson 1986: 113).

Many elements of Thule material culture, such as ulus and dog sleds, were used into historic times. In Western Alaska there appears to have been a relatively smooth, unbroken transition from the prehistoric Western Thule culture, to the Kotzebue Period culture, to the late prehistoric Inupiat period that lasted until 250 years BP, and finally to the historic and modern Inupiat culture (Schaaf et. al. 1988;

Dumond 1987: 44). Because of this continuity, research on Thule culture is aided by the ethnographic information on the Inupiat culture.

Plant Use in the Arctic

Historical Accounts

Ethnographic information from modern and historic Alaskan Native groups can help supplement and strengthen archaeological data. The modern Inupiat and Yup'ik are coastal Native groups in Western Alaska. From the Kotzebue Sound to the Alaskan Peninsula (Figures 1.1 and 1.2), these groups use a total of 57 known plant species for food, and 47 species for medicine (Young and Hall 1969: 43). Other plants are used for various purposes ranging from basket making to ritual use (Oswalt 1957: 17). Alaska has relatively abundant plant growth when compared to other areas in the Arctic, but the flora is still too sparse to contribute significantly to the food supply (Birket-Smith 1971: 102).

Plant foods are thought to constitute 10% of the calories in the traditional Napaskiak Yup'ik diet, but only 5% of the Bering Strait Inupiat diet (Oswalt 1957: 35). Inupiaq and Yup'ik people from Kotzebue to the Alaskan Peninsula may receive upwards of 15% of their diet from plants (Young and Hall 1969: 43). On St. Lawrence Island, fewer than half of the species that grow on the Seward Peninsula are found, and only as little as 4% of the diet may come from plants (Young and Hall 1969: 44, 50).

Even in communities where plants provided only 1-2% of the total calories consumed annually, this small amount was enough to provide 50% of their Vitamin

C needs. This amount of plant consumption also provided the main source of dietary fiber – something largely lacking in meat foods (Jones 2010: xvii, 146).

Wild edible Alaskan plants are highly nutritious. Certain species of greens are rich in carotene (vitamin A), and other species of leafy greens, cloudberries (*Rubus chamaemorus*) and rosehips (*Rosa* sp.) all contain a high amount of ascorbic acid (vitamin C). If these wild resources are prepared and preserved properly they can retain much of their nutrients for extended periods of time. For example, cloudberries that are frozen immediately after picking and kept frozen will retain the majority of their vitamin C (Heller 1976: 1; Jones 2010). It is not necessary to eat large amounts of these plants in order to ensure an adequate intake of these vitamins. If nutritious plants are eaten daily, or at least several times a week, vitamin deficiency is unlikely (Heller 1976: 1).

Commonly consumed plants and their nutritional values are listed in Table 1.1 as summarized from Jones 2010 (199). Note that vitamin A values are listed in I.U.'s or international units while ascorbic acid values (vitamin C) and other nutrients are listed as milligrams. These nutrients, while lacking for the most part in animal products, are abundant in plant foods. Again, although plant foods are generally low in calories, their rich nutritional values make them an essential part of a traditional Alaskan Native diet.

Table 1.1: Nutritional Composition of Alaskan Plant Foods, per 100 g (data from Jones 2010: 199)

Common Name	Scientific Name	Calcium, mg	Phosphorous, mg	Vitamin A, I.U.	Ascorbic Acid, mg
Fireweed	*Epilobium latifolium*	13	89	5720	99
Low-bush cranberry	*Vaccinium vitis-idaea*	26	21	90	21
Masru	*Hedysarum alpinum*	0	67	16	11
Pink Plume *ippik*	*Polygonum* sp.	22	175	150	16
Mousenuts	*Eriophorum* spp.	17	150	340	8
Wild Rhubarb	*Polygonum alaskanum*	0	87	4480	33
Cloudberry	*Rubus chamaemorus*	18	35	210	158
Stonecrop Roseroot	*Sedum rosea*	1	20	6250	79
Sourdock	*Rumex arcticus*	2	55	11900	68
Willow *sura* (raw)	*Salix pulchra*	130	126	18700	190
Willow sura (in seal oil)	*Salix pulchra*	0	58	18700	0

Plant use is highly influenced by seasonality because the Arctic growing season is so short. Beginning in early summer, the first plant food resources become available (Anderson et al. 1988: 54). Vegetable resources including Sea Lovage (*Ligusticum scoticum*), various greens such as Sourdock (*Rumex arcticus*), Beach Greens (*Honkenya peploides*), Eskimo Potatoes (*Hedysarum alpinum*), and willow leaves (usually *Salix pulchra*), are gathered for consumption during the early part of the growing season (McIntosh 1999: 15). By August, blueberries (*Vaccinium uliginosum*), cranberries (*Vaccinium vitis-idaea*), cloudberries (*Rubus chamaemorus*)

and other fruits are available (Anderson et al. 1988: 54; McIntosh 1999: 35).

In the Shishmaref area, inhabitants used plant resources all year round - summer, fall, winter and spring. When berry picking is good, everyone helps gather berries on the mainland (McIntosh 1999: 25, 34). Among the Kuuvangmiut Inupiat of the Kobuk River valley, however, it was the women and children who were responsible for gathering edible plants. During the summer, wild rhubarb (*Polygonum alaskanum*) and willow (*Salix pulchra*) leaves were gathered for consumption. It was also during the summer that nets were made from willow bark (Anderson et. al. 1988: 54). In August, the blueberries, cranberries, currants (*Ribes triste*) and other fruits had ripened, and were ready for picking (Anderson et. al. 1988: 54-55; Giddings 1956: 17). See Table 1.2 for a list of a number of major plant resources, and when they were available during the summer.

Table 1.2: Summer Plant Availability (summarized from Jones 2010, McIntosh 1999)

Early Summer Plant Taxa		Late Summer/Fall Plant Taxa	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Beach Greens	*Honkenya peploides*	Bearberries	*Arctostaphylos alpina*
Eskimo Potato	*Hedysarum alpinum*	Bog Blueberries	*Vaccinium uliginosum*
Sea Lovage	*Ligusticum scoticum*	Cloudberries	*Rubus chamaemorus*
Sourdock	*Rumex Arcticus*	Crowberries	*Empetrum nigrum*
Willow leaves (*sura*)	*Salix pulchra*	Low-Bush Cranberries	*Vaccinium vitis-idaea*

In an archaeological context, knowing what plant taxa were available during what time of the growing season can help provide precise information about

seasonality. Assuming that edible plants were consumed immediately after gathering, finding taxa such as Beach Greens (*Honkenya peploides*) and Sourdock (*Rumex arcticus*) would indicate an early summer occupation, whilst the presence of various berries would more strongly suggest a late summer and early fall occupation. The presence of both early summer and late summer taxa suggest a site may have been occupied for the entire summer, or when paired with other seasonal indicators (house type, fuel wood type, and faunal assemblages) may indicate that a site was inhabited throughout the majority of the year, or that plants gathered during the summer were preserved for later consumption.

After gathering, plant foods could either be prepared for immediate consumption, or preserved and stored for winter consumption. Berries are eaten immediately, or preserved in oil, dried or frozen for use during the following winter (Anderson et al. 1988: 54; McIntosh 1999: 35). Similarly, the greens and tubers mentioned above, such as Eskimo Potato or *masru* (*Hedysarum alpinum*), were stored in seal oil for winter consumption (Anderson 1939: 714-715).

Inupiat people also traditionally gathered *pitniq*, the bottom part of cotton grass (*Eriophorum angustifolium*) stems from mouse and vole caches. Rodents dig up this part of the plant, trim off the root hairs, and then store them for their own winter consumption. It is a nutritious food, but it is tedious and time consuming for people to gather without taking it from rodent caches. *Masru,* or Inupiat Potato (*Hedysarum alpinum*) is also gathered from mice caches together with *pitniq*, and both are stored in seal oil (Jones 2010: 141, 148-149).

Seal oil keeps the vitamin C content of the greens from being destroyed from contact with the air, and also allows oil-soluble vitamins such as vitamins A, D and E to move into the oil itself (Jones 2010: 3). As has been done into modern times, the oil would be served with meat or fish at meals, allowing the consumer to eat both meat and greens simultaneously. In particular, berries might be preserved in animal fat to be served as *agutuk* – Eskimo ice cream (Zutter 2009: 30; Oswalt 1957: 20; Jones 2010: 3, 188; McIntosh 1999). To keep food throughout the winter, meats and greens were often stored in subterranean cache pits (Schaaf 1996: 45; Rainey 1947: 253; Anderson et. al. 1988: 50), probably similar to those cache pits found at Cape Espenberg and many other prehistoric sites (Mason and Gerlach 1995b: 115).

In northwest Alaska, cloudberries (*Rubus chamaemorus*) are the most sought after berry (Jones 2010). In Yup'ik territory in southwest Alaska, all other berry species were only picked incidentally while seeking out this particular fruit (Oswalt 1957: 20). Cloudberries were occasionally eaten raw, but were usually saved to make *agutuk*. In Napaskiak, Yup'ik locals liked to make their Eskimo ice cream in the 1950's with seal oil, commercial lards, many cloudberries, a little bit of sugar, some boiled fish, sourdock (*Rumex arcticus*), horsetail (*Equisetum arvense*), mare's tail (*Hippuris vulgaris*) and woodfern (*Dryopteris spinulosa*) plants (Oswalt 1957: 20). The exact ingredients varied by season, but the berries and seal oil were the essential ingredients of the dish. After preparation, the *agutuk* was put in cold storage so that the fats would congeal. Once the mixture was solid, it was ready to serve. This was a favorite dish in Napaskiak 60 years ago, and an adult might eat two

or three measuring cups full in a single sitting (Oswalt 1957: 21).

Plant foods could be prepared for more immediate consumption in several different ways. Berries, rose hips (*Rosa acicularis*), willow (usually *Salix pulchra*) and fireweed (*Epilobium angustifolium*) leaves were eaten raw, as were two lichen species that were used as seasonings. Dried fireweed leaves could also be used to brew tea. Other cooked plants were added to hearty, meaty soups or stews. Sourdock (*Rumex arcticus*) was eaten with seal oil (Oswalt 1957: 20).

Among the Napaskiak Yup'ik, medicinal plants such as stinkweed (*Artemisia tilesii*) were boiled to make tea, or used as poultices (Oswalt 1957: 30). Stinkweed is effective for relieving cold symptoms. Another plant, sourdock (*Rumex articus*), besides being edible, is also a potent astringent. The Napaskiak also used tall cotton grass, white spruce (*Picea glauca*), and false-chamomile (*Matricaria perforata*) for medicinal properties.

In Northwest Alaska, stinkweed is also used to relieve cold symptoms, and additionally used as a poultice to wrap infected wounds. The Inupiat also acknowledge the medicinal properties of sourdock and white spruce (Jones 2010: 160-161, 45, 166). Many other plants in Northwestern Alaska including crowberry (*Empetrum nigrum*), wild celery (*Angelica lucida*), bistort (*Polygonum bistorta*), Labrador tea (*Ledum palustre*), coltsfoot (*Petasites frigida*), willow bark (*Salix* sp.) and several others have been used medicinally in modern and historic times (Jones 2010).

Other plants were used ritually. Mummies buried at Qilakitsoq in Greenland

were laid out on flowers and grasses – evidence of ritualistic plant use (Brescani et. al. 1991). In historic times, the most important ritual plants to the Napaskiak were wild celery (*Angelica lucida*) and other umbel or umbel-like plants (plants with flower stalks that are spread out somewhat like an umbrella) and Labrador tea (*Ledum palustre*) (Oswalt 1957: 31, 36).

Archaeological Accounts

The ethnographic accounts above show how plants played an important part in the subsistence economies of coastal Alaskan Natives. In order to understand how plants were used in prehistoric times, archaeological accounts from the Arctic must be considered. Only a small number of studies have been conducted on prehistoric Inuit and paleo-Eskimo plant use, the majority of which have been carried out in the Eastern Arctic. Qeqertasussuk, Port au Choix and Uivak are the three better-known sites where archaeobotanical studies have been conducted in the far north.

The paleo-Eskimo site of Qeqertasussuk in West Greenland is dated to 3900-3100 cal. BP (Bocher and Fredskild 1993: 3). Note that all dates are presented in calibrated years before present. A probable midden at Qeqertasussuk contained a cultural layer rich in twigs. This suggests that twigs may have been collected for fuel, or used to create a floor or bed covering. However, the function of these twigs is unclear (Bocher and Fredskild 1993: 10).

Many leaves and fruits from *Betula nana* were recovered, which are interpreted by Bocher and Fredskild (1993: 10) to indicate late summer gathering.

Many crowberry (*Empetrum nigrum*) seeds, but few leaves, were recovered from Layer 5a (not the lowest level). This is interpreted as a possible latrine, but Bocher and Fredskild (1993: 10-11) caution that the presence of robust *Empetrum* seeds and the lack of *Empetrum* leaves could simply be an artifact of taphonomy because the fleshy leaves may have decayed before the tough seeds.

Although it is not a paleo-Eskimo site, two archaeological components from Port au Choix, Labrador dated from the Maritime Archaic period (6290-3340 cal. years BP) and Recent Indian period (2110-1330 cal. years BP) provide data about very early plant use in the Far North. In the site's earlier component, seven probable edible plant species (mostly berries such as *Rubus idaeus, Prunus pensylvanica, Sambucus pubens* and *Vaccinium angustifolium*), two fuel or construction species (*Picea* sp. and *Betula papyrifera*), one other usable plant species (grasses of the *Poaceae* family) and five contaminant species were recovered. The Recent Indian contexts yielded three probable edible plant species, three fuel or construction species, and three contaminant species. Edible berry seeds (same as the ones mentioned previously) recovered from the site indicate it was in use at least during the summer and early fall (Deal 2005: 131, 150).

Much of what is currently known concerning specifically Thule plant use comes from research done by Cynthia Zutter at an 18th century Thule house at the Uivak site in Labrador (Zutter 2009). Unlike Cape Espenberg, the Uivak site is right at treeline. Here Zutter (2009) found that plants – especially berries – made up an important part of the Thule diet. Bulk macrobotanical samples were taken from the

floor, midden, sleeping platform and entranceway of the house. From these samples, Zutter recovered over 15,500 plant macrofossils from 26 different taxa. Crowberry was the most abundant. White spruce also had high concentrations – as high as 702 needles per liter (Zutter 2009: 24). For comparison, off-site samples had much lower concentrations of macrobotanical remains at only 300 items per liter on average (Zutter 2009: 24). The high concentration of macrofossil remains in cultural contexts suggests that they were anthropogenically introduced.

Macrofossils recovered from a single coprolite were almost exclusively (99%) edible plants. A total of 10,100 seeds were found in this coprolite, representing approximately 1,222 individual *Empetrum nigrum* and *Vaccinium* berries. The absence of pedicels (berry stems) strengthens the notion that this was a human coprolite rather than a bear scat. There were also animal fat globules found in the coprolite. This combination may suggest the consumption of Eskimo ice cream (*agutuk*) (Zutter 2009: 30).

Ultimately, the different taxa recovered from the Uivak, Labrador site suggest that plants foods helped to contribute necessary nutrition to a largely meat-based diet. Zutter's research shows that other plant species (like spruce needles) were used for the manufacture of sleeping platform mats and other essential implements (2009: 31). Zutter concludes that, although the world's northernmost peoples may have relied heavily on meat, plants harvested for consumption and other purposes remained an essential resource throughout the year.

Fuel Use in the Arctic

Wood Supplies in the Arctic

The other major focus of this thesis is fuel use, primarily woody fuel use. In the treeless Arctic, driftwood was the main source of wood for prehistoric peoples, and their descendants, the historic Inupiat and Inuit (Alix 2005). Driftwood in the Arctic originates from the boreal forests of North America and Siberia, and is transported by river and ocean currents, sea ice, and driven by the prevailing wind. The Western Arctic coasts are closer to the Alaska's boreal forest - the source of driftwood, and thus its coasts receive more timber than areas farther away from the boreal forests, such as the eastern Arctic. Driftwood is also typically fresher and less damaged in the western Arctic (Alix 2009a: 179-181).

The quantity and quality of driftwood deposited in a given region is variable. The amount of driftwood available to local inhabitants affects how it is used. In Northwestern Alaska during historic times, it seems that wood was used as fuel mostly in areas where driftwood was abundant (Alix 2005: 84).

In Northwest Alaska today, driftwood deposits consist primarily of spruce (*Picea glauca, Picea mariana*), poplar – cottonwood for the most part (*Populus balsamifera)* – willow (*Salix* sp.), and infrequently, alder (*Alnus* sp. cf. *Alnus crispa* and *Alnus tenuifolia*), and paper birch (*Betula neoalaskana)* (Alix 2005, 2008). The amount of deciduous wood (*Populus, Salix, Alnus* and *Betula*) in Arctic driftwood deposits is typically low – usually around 30 to 40% of a driftwood assemblage (Alix 2009a: 190). In general, since the composition of the boreal forest has not changed

significantly for the past 5,000 or 6,000 years, the taxa found in driftwood deposits today are similar to what was found in Thule times. The ratio of these taxa, and the abundance and distribution of driftwood, however, may have changed in some areas (Alix 2009a: 181).

In some places, there is evidence that driftwood deposition has changed dramatically since Thule times, particularly in terms of abundance. The Ruin Islander Thule houses on Skraeling Island in Nunavut, Canada, from about 800 to 700 cal. BP, contain a large amount of worked wood and wooden objects (Alix 2009b: 151). In the 19th and 20th centuries, the Polar Inuit living in the same region had very little available driftwood in comparison, suggesting that driftwood deposition patterns may have changed significantly since Thule times or that another source of wood has been involved prehistorically (Alix 2009b: 153). The possibility that driftwood accumulations may have changed through time must be kept in mind when studying woody remains at Thule sites, and also when using ethnographic analogies.

Some scattered stands of treeline trees may have been available to prehistoric Arctic peoples (Alix 2007: 95), but in most areas there were only woody shrubs. Shrubby willow (*Salix* spp.), dwarf birch (*Betula nana* or *Betula glandulosa*) and crowberry (*Empetrum nigrum*) grow relatively abundantly at Cape Espenberg, but rarely grow higher than half a meter in height (Schaaf et. al. 1988). In the High Arctic, these shrubs tend to be much smaller, and keep close to the ground (Pielou 1994: 112). Since most areas in the Arctic cannot support tree growth, driftwood

and woody shrubs were the only two sources of wood. At least in the sub-arctic, driftwood likely provided the majority of woody fuel to prehistoric peoples, based on what is known from ethnographic modern data – even where some terrestrial wood stands were available (Deo-Shaw 2008). In northern, treeless areas, driftwood has also been the main source of wood for modern peoples (Alix 2005: 83). This was presumably true at Cape Espenberg during Thule times.

Historical Accounts of Fuel Use in the North

Apparently, the local availability of fuel greatly influenced whether historic Inupiat people decided to settle at a given location (Burch 2006: 296). Having a reliable and continued fuel supply was as important as maintaining adequate food supplies throughout the winter (Burch 2006: 52). This was probably the case in prehistoric times as well (Alix 2009b: 149; Deo-Shaw 2008: 7).

Historically, the Inupiat of Northwest Alaska accessed and used fat and wood as their primary fuel sources. Fatty fuels came in the form of oil or blubber, largely procured from sea mammals. In a typical Thule dwelling, an oil lamp would have provided the majority of light and heat for the inhabitants occupying the main room of the house.

For northern peoples in general, oil lamps lighted and heated dwellings, and cooked foods by boiling in pottery or stone containers (Birket-Smith 1929: 97-104). In modern times, the inhabitants of Kivalina, Alaska – an area just north of Cape Espenberg – would conserve their wood supplies and prolong the life of their fires

by mixing wood with blubber. Saario and Kessel (1966: 972) noted that "40 pounds of blubber will last for about a day if burned alone, but will last two or three days if burnt with wood." Both access to wood and blubber were important to the Inupiat, and probably the Thule, when choosing settlement locations.

Throughout the year the Inupiat collected driftwood where it was available. During the autumn months, in anticipation of winter, driftwood collection intensified. A local abundance of driftwood, particularly fresh, non-waterlogged driftwood, was a factor in choosing a winter settlement location - especially if new houses needed to be constructed (Fair et. al. 1996: 65; Alix and Brewster 2004: 6).

Firewood is preferred or selected according to the properties of the wood, and the intended function of the fire (Alix and Brewster 2004; Deo-Shaw 2008). Ethnographic sources indicate that during the 19th century in the Kotzebue Sound region, spruce was often selected for fuel, partially because of its abundance. Birch, willow and poplar were less valued as firewood (Anderson et. al. 1988: 238-239). Dry spruce and alder are superior firewoods because they produce a hot, clean-burning fire (Alix and Brewster 2004: 9; Deo-Shaw 2008: 54).

The ethnographic selectivity of wood suggests that while the remains of woody materials at a site may reflect the species that are available locally, they do not necessarily reflect the percentage of tree species in the local driftwood assemblages or on the landscape. Instead, the woody resources found at modern sites can be seen as a representation of an economic system with differential selection of wood according to availability, varying climatic conditions, seasonality,

and purpose (Henry et al. 2009: 24). Presumably this was true in prehistoric times as well.

When Inuit groups in the Central Arctic moved inland to hunt during the spring and summer, they would burn driftwood. Even though these people might be nine or 12 kilometers from the coast, they would still carry driftwood with them. When their driftwood supply ran out, they would resort to inferior fuel sources and collect wood from local willow (*Salix* spp.) shrubs (Stefansson 1919). This same practice has not been reported in Alaska where driftwood is available along rivers, but this example serves to emphasize the general preference for driftwood in the far North.

If local willow supplies were exhausted, the Inuit of the Central Arctic and the Inupiat of Western Alaska resorted to burning the abundant local heather (*Cassiope tetragona*). This fuel source can even be dug up from under the snow if necessary. Although it is abundant and easy to gather, at least in Western Alaska, Inupiat people found cooking with heather to be degrading (Birket-Smith 1929; Heizer 1963: 190), and hence, they preferred instead to haul driftwood to their camps. Heather was a fuel source of last resort for historically known Western Alaskan Inupiat because of its lowly association (Birket-Smith 1929).

Past Studies on the Use of Fuel in Archaeological Contexts: Paleo-Eskimo Sites

Archaeological studies focused on fuel use have been conducted both at paleo-Eskimo and other prehistoric Inuit and Thule sites. At the paleo-Eskimo site of Qeqertasussuk, West Greenland, it seems that inhabitants may have collected shrubby vegetation for fuel, or as a floor covering – the ultimate function is unclear (Bocher and Fredskild 1993: 10).

There are similar remains at the Pre-Dorset site of Umingmak on Banks Island, Northwest Territory dated to 3600 radiocarbon years BP (Schweingruber 1977: ii). Of the 895 pieces of charcoal collected at Umingmak from various archaeological and geological levels, only one piece of *Picea* (spruce) was found. This is the only charcoal fragment that is definitely not local vegetation. The other 894 charcoal fragments were indentified as dwarf willow (*Salix arctica*), a species that grows extensively in the local area (Schweingruber 1977: 105).

Schweingruber concludes that the inhabitants of Umingmak gathered wood from this plant, dried it and then burned it slowly. The evidence is inconclusive, but the author does not exclude the possibility that the inhabitants at Umingmak were smoking fish or meats (Schweingruber 1977: 106). Dwarf willow grows very slowly, only about 0.1 to 0.2 mm annually on Banks Island, and produces woody growth only two months out of the year. This means that this wood source was probably quickly exhausted. The wood was gathered during the summer months, as evidenced by the presence of bark on charcoal, and incomplete final annual growth

rings. Barring that the inhabitants were collecting wood for the winter, Umingmak was probably a summer habitation where musk oxen meat was dried in preparation for winter (Schweingruber 1977: 106-110).

Past Studies on the Use of Fuel in Archaeological Contexts: Thule Sites

Moving onto Thule sites specifically, at Deering, Uivvaq and Walakpa (see Figure 1.2), coniferous wood is, without exception, favored over deciduous wood for the manufacture of wooden artifacts (Alix 2009a: 182-184). Modern driftwood accumulations, however, are usually about 40% deciduous wood, implying that the Thule and other Neo-Eskimo peoples may have had a preference for coniferous wood. Alternatively, it could mean that the composition of driftwood accumulations have changed since prehistoric times (Alix 2003: 200).

This evidence does not necessarily prove that the Thule similarly chose coniferous wood for firewood, but when paired with ethnographic information that shows a similar preference for coniferous wood for fuel – primarily spruce – there could be a link between the preference for wood for manufacturing, and the wood for burning (Anderson et. al. 1988; Alix and Brewster 2004; Deo-Shaw 2008).

At Thule sites such as Uivvaq in Alaska and Cape Espenberg, wood seems to have been used frequently as fuel, although wood was not universally used as a primary fuel source (Alix 2005: 84). At Uivvaq, analyses of charcoal from middens show that the inhabitants took advantage of the woody resources available in the area. Driftwood and local shrubs alike were used for fuel (Alix 2003: 193). The

remnants of bark on burnt twigs witness the use of locally growing vegetation for fuel (Alix 2003: 199). Carbonized remains of spruce (*Picea* sp.), willow (*Salix* sp.), birch (*Betula* sp.) and alder (*Alnus* sp.) were identified. The presence of spruce/larch (*Picea* sp./*Larix* sp.) and poplar (*Populus* sp.) wood chips show that these species were worked as well as burnt at Uivvaq. The quantity of burnt wooden remains was low, however, and there is abundant evidence that bones were also burnt for fuel (Alix 2003: 193, 197, 218-219).

Although Thule people may not have always used wood for domestic purposes such as heating and cooking, wood was universally necessary for firing ceramics. Anderson et. al. (2011) assert that fuel is the costliest element in pottery production. The limited availability of woody fuel may explain the relatively fragile and low quality of Thule ceramics (Anderson et. al. 2011; Frink and Harry 2008: 12). A large amount of wood is needed for attaining the high temperatures required to fire ceramics. In light of how much wood is needed for firing, coupled with the limited availability of fuel wood in the Arctic, it makes sense that Thule ceramics were often fired at low temperatures. In fact, most Thule vessels were never fully fired, but merely fire-hardened, despite their small size (Anderson et. al 2011: 104).

In summary, wood has been an important resource to Arctic peoples throughout in modern, historic and prehistoric time. For the Thule people across the Arctic, wood, primarily in the form of driftwood, was essential for a number of purposes including fuel. In the next chapter, the woody resources of Cape Espenberg specifically are considered, as well as its other plant resources.

Chapter 2: Cape Espenberg and the Kotzebue Sound Area

Geographical Setting and Environmental Conditions

Cape Espenberg is a 29 km long sandy spit located on the northwest coast of Alaska at 66°30'N, 163°30'W, in the Bering Land Bridge National Preserve (see Figure 1.1). It is the northernmost extension of the Seward Peninsula, pushing into the Kotzebue Sound just below the Arctic Circle. The spit is comprised of an accumulation of beach ridges and sandy dunes formed by storm activity throughout the last five millennia of the late Holocene (Mason 1990; Mason et. al. 1997; Mason and Gerlach 1995b: 109). Between the sandy beach ridges are marshy swales and numerous oblong thaw ponds (Mason 1990; Wilson et. al. 2007: 2). It is more than 100 km away from treeline, and within the region of continuous permafrost (Mason 1990: 116).

The climate of Cape Espenberg is comparable to that of the larger Kotzebue Sound region. Using NOAA climatic data from Kotzebue, Alaska – a town about 55 km to the northeast - the average yearly temperature is around -6 degrees Celsius with mean July temperature of around 13 degrees Celsius. This estimate is based on a 30-year average from 1971-2000. Kotzebue, Alaska receives an average of 255 mm of precipitation annually (NOAA Climate Means 1971-2000). The climate of

Cape Espenberg is similar; it has moderate, maritime summers with cold, windy winters. The coast is ice fast from November to early June (Leslie 1986).

Modern Plant Resources at Cape Espenberg

The flora of Cape Espenberg is distinctive. Much of the landscape, unlike that in surrounding environs, is well drained. This is due to the dunes that make up most of the spit. Like the greater Kotzebue Sound region, the cold, cool environment of Cape Espenberg is too harsh to support tree growth. The brief growing season allows only procumbent, shrubby tundra vegetation to thrive in the region (Sobelman 1985: 25; Shulski and Wendler 2007: 158). The most abundant shrubs include three species of willow (see Table 2.1.), dwarf birch (*Betula nana*) and crowberry (*Empetrum nigrum*) among others (McIntosh 1999: 13; Schaaf et. al. 1988; Schaaf 1987). The tallest vegetation typically grows no more than half a meter tall.

The vegetation generally consists of dry heath type plant communities atop higher, well-drained beach ridges, and moist acidic tundra type vegetation in the wet swales and low-lying areas (McIntosh 1999: 13; Schaaf 1987; Sobelman 1985: 25). Common plant species at Cape Espenberg include those listed in Table 2.1. Many of the plant species listed here come from Jeanne Schaaf's (1987) unpublished vegetation survey conducted in the Bering Land Bridge National Park while the others are from Hultén (1968) and/or have been noted during visits to Cape

Espenberg by members of the CEP (such as *Cassiope tetragona* which grows at the spit, but is not acknowledged by Hultén 1968).

Table 2.1: Plant Species of Cape Espenberg (Schaaf 1987).

	Common Name	Scientific Name
Shrubs	Bog Rosemary	*Andromeda polifolia*
	Bearberry	*Arctostaphylos alpina*
	Dwarf Birch	*Betula nana*
	Arctic Bell-Heather	*Cassiope tetragona*
	Crowberry	*Empetrum nigrum* spp. *hermaphroditum*
	Alpine Azalea	*Loiselueria procumbens*
	Northern Cinquefoil	*Potentilla villosa*
	Cloudberry	*Rubus chamaemorus*
	Grayleaf Willow	*Salix glauca*
	Diamondleaf Willow	*Salix planifolia* spp. *pulchra*
	Netleaf Willow	*Salix reticulata*
	Bog Blueberry	*Vaccinium uliginosum*
	Low-Bush Cranberrry	*Vaccinium vitis-idaea*
Herbs	Tilesius' Wormwood	*Artemisia tilessii*
	Alpine Milkvetch	*Astragalus alpinus* ssp. *alpinus*
	Sedges	*Carex* sp.
	Arctic Daisy	*Chrysanthemum arcticum*
	Field Horsetail	*Equisetum arvense*
	Arctic Cottongrass	*Eriophorum callitrix*
	Arctic Flag	*Iris setosa*
	Arctic Rush	*Juncus arcticus*
	Labrador Tea	*Ledum palustre*
	Lousewort	*Pedicularis* sp.
	Alpine Bistort	*Polygonum viviparum*
	Arctic Wintergreen	*Pyrola grandiflora*
	Hawkweed-Leaved Saxifrage	*Saxifraga hieracifolia*

Cape Espenberg is unique in that berries grow abundantly – especially blueberries (*Vaccinium uliginosum*), low-bush cranberries (*Vaccinium vitis-idaea*), cloudberries (*Rubus chamaemorus*), crowberries (*Empetrum nigrum*) and

bearberries (*Arctostaphylos alpina*) (Jones 2010: 133). By far, berries dominate the ridgetops and drier swales. Crowberries (*Empetrum nigrum*) are ubiquitous.

Today, driftwood is relatively sparse at Cape Espenberg. Recent research at Cape Espenberg show that driftwood accumulations consist primarily of spruce (*Picea glauca, P. mariana*), poplar - mostly cottonwood (*Populus balsamifera*) - willow (*Salix* sp.), with rare appearances of alder (*Alnus* sp. cf. *A. crispa* & *A. tenuifolia*), paper birch (*Betula neoalaskana*) and larch (*Larix* sp.). Paper birch arrives more frequently at Cape Espenberg than in other areas north of the Kotzebue Sound, but still arrives with relatively low frequency. As elsewhere, bark fragments of both cottonwood and birch trees are abundant in the small debris.

Fauna

Besides considering plant resources, the animal resources that made Cape Espenberg attractive to prehistoric settlers deserve mention. Cape Espenberg is home to many game species that indigenous peoples have hunted in prehistoric, historic and modern times (Wisniewski 2005: 6; Ellanna and Sherrod 2004: 42; Wilson et. al. 2007: 2-10; Burch 1998: 295). Caribou (*Rangifer tarandus granti*), musk oxen (*Ovibos moschatus*) and moose (*Alces alces*) are the major land mammals. Waterfowl species such as sandhill cranes (*Grus Canadensis*), pacific common eiders (*Somateria mollissima*) and red-throated loons (*Gavia stellata*) are abundant.

In the greater Kotzebue Sound region, streams and rivers are inhabited by several different species of whitefish (*Coregonus* spp.), and salmon (*Onochorynchus*

spp.). Various species of seals such as the bearded seal (*Erignatus barbatus*), ringed seal (*Pusa hispida*) and spotted seal (*Phoca largha*) inhabit the waters of the Kotzebue Sound. Walruses (*Odobenus rosmarus*) are sometimes present offshore, as are occasional pods of beluga whales (*Delphinapterus leucas*) and other whale species (Wisniewski 2005: 6, Ellanna & Sherrod 2004: 42, Wilson et. al. 2007: 2-10, Burch 1998: 295). Presumably, there is similar availability of these aquatic resources at Cape Espenberg or in the surrounding environs.

The Archaeology of Cape Espenberg

History of Human Occupation at Cape Espenberg

A survey of the area reveals that the natural landscape of Cape Espenberg has been obviously impacted by human activity. Numerous, oval or rectangular house depressions, usually about 4 m in diameter, are easily recognizable on the surface (see Figure 2.1), sometimes along with their connected arctic entryways (Mason 1990: 142). Sites at Cape Espenberg include cache pits, house depressions, burials and isolated artifact scatters (Mason and Gerlach 1995b: 115). The largest sites are found on the easternmost part of the spit, and are often built near small drainages that meander across the sand dunes into the Chukchi Sea. Conversely, few sites are found in the middle or western half of the dune ridge succession of the spit. In terms of understanding the Western Thule phenomena, Cape Espenberg appears to be a location nearly as important as Cape Krusenstern to the north (Mason and Gerlach 1995b: 115, 117). See Figure 2.1 and note just how much of the landscape is covered

with archaeological features. The housepits and off-site pits excavated in the 2010 and 2011 field season are indicated on this map as well.

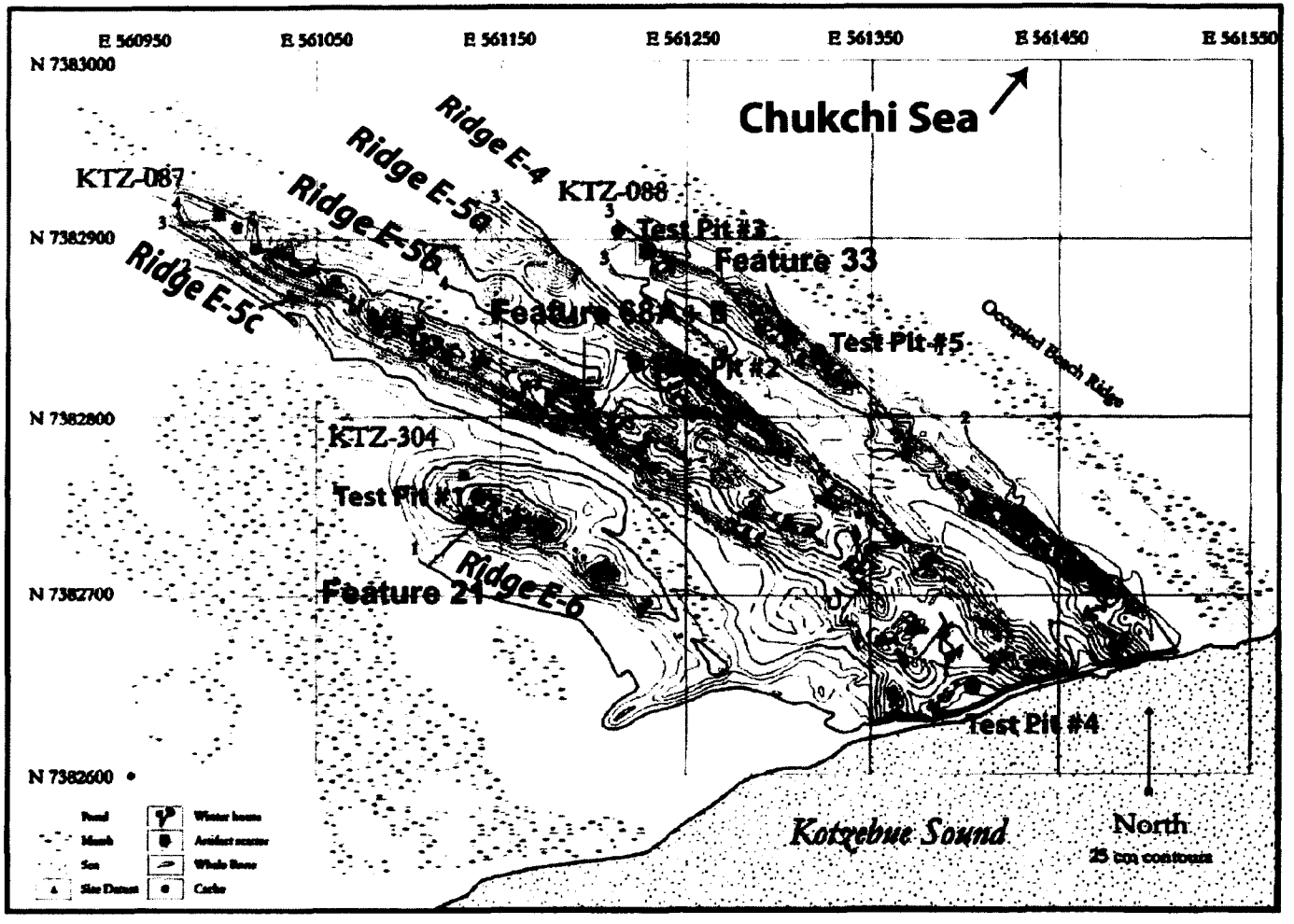


Figure 2.1: Site Map (Adapted with permission from John Darwent, U.C. Davis from Hoffecker and Mason 2010)).

Cape Espenberg has been intermittently inhabited for the last 4,000 years or so, abandoned and reoccupied, presumably during periods of lesser and greater resource attractiveness. Figure 2.2 summarizes the inhabitation of the area. The first inhabitants of the spit were people of the Arctic Small Tool tradition (ASTt). This tradition is thought to have been largely inland-based (Mason and Gerlach 1995b: 116) developing on mainland Arctic North America in the interior tundra, and then later expanding and adapting to coastal areas (Anderson 1981). The ASTt receives its names from the small knapped stone tools, called microblades, used by these ancient people. This early occupation is relatively poorly dated, but it is apparent that the ASTt sites at Cape Espenberg date to the same time period as other ASTt occupations in Northwest Alaska, from about 4000-3300 C-14 years B.P (Mason and Gerlach 1995b: 101, 116).

After a 400-year hiatus, Choris people moved onto the spit around 2900 C-14 years BP (Mason and Gerlach 1995b: 116). The greatest concentration of Choris materials comes from only three areas in Alaska, one of which is Cape Espenberg (Mason and Gerlach 1995a: 11). Based on faunal data, it appears that the Choris economy was maritime based, and that their primary food sources included ringed seal, pink salmon (*Oncorhynchus gorbuscha*) and dog salmon (*Oncorhynchus keta*). Walrus and whale seem to have only rarely been used. Choris people also subsisted on caribou (Mason and Gerlach 1995a: 6).

On the Choris peninsula in the Kotzebue Sound– not too far north of Cape Espenberg (see Figure 1.1), the Choris people had ornamental labrets, oil lamps,

inset points, and ceramics (Mason and Gerlach 1995a: 6) inscribed with paddle pressed linear impressions, parallel grooves and check stamps (Dumond and Bland 2006). On a geographically grander scale, Choris remains are distinguished by large, diagonally flaked bifaces with shouldered hafting in the middle. Also common in Choris assemblages are flaked lanceolate spear points with either concave or stemmed bases. Choris people also used slate occasionally (Mason and Gerlach 1995a: 9).

There is no apparent hiatus between the Choris and Norton occupations at Cape Espenberg. Choris sites have calibrated dates of *ca.* 2970-2800 cal. BP, and dated Norton sites calibrate to *ca.* 2765-2520 cal. BP. These dates are based solely on four Choris and Norton occupations at Cape Espenberg. Some dates suggest however, that Norton people may have continued to occupy the area until as recently as *ca.* 2100 cal. BP (Mason and Gerlach 1995b: 116). At other sites, it seems that Norton people occupied coastal areas more continuously than preceding cultures, but still continued to focus on sealing, and caribou hunting, in addition to a "casual" interest in whaling (Harritt 1995: 36). At Cape Krusenstern, Norton people are further characterized by their annual return to substantial winter houses, their reliance on fishing and hunting of smaller land mammals, as well as prevalent pottery use (Giddings 1964).

Following the occupation of Cape Espenberg by Norton people, there is a gap that extends from at least 2100 cal. BP to 1400 cal. BP. This occupation gap, dates suggest, may be up to 1,000 years in length. After this extended depopulation,

people belonging to the Ipiutak culture moved onto the spit (Mason and Gerlach 1995b: 116).

The Ipiutak were an enigmatic people who seem to have spent considerable amounts of time inland (Giddings 1952: 117; Mason 1998: 276), passing their winters inland hunting caribou, and returning to the coast in the spring to hunt seal and walrus – opposite the winter-on-the-coast, summer-inland pattern often seen with other prehistoric coastal groups (Chance 1966: 11; Anderson 1962, 1972; Larsen and Rainey 1948). Furthermore, the Ipiutak culture is distinctive because of its lack of ceramics, ground slate implements, lamps and harpoon floats (Collins 1943: 221; Harritt 1995: 36; Mason 1998: 273). The Ipiutak culture's heavy reliance on caribou may have required a high level of mobility, which may have made ceramic production less practical to use and produce (Mason 2002: 226).

The Ipiutak, however, are probably best known by their elaborate artwork on weapons, tools, and especially burial goods (Anderson 1978: 45-46; Giddings 1961: 168). Burial objects include ivory carved into chain links, abstract pretzel-like objects, animal and anthropomorphic figures, and artwork inscribed with elaborate geometric designs (Anderson 1972, 1981; Dumond 2000: 6; Mason 1998: 273; Mason 2009: 85). Most striking are the Ipiutak "death masks" that are suggestive of shamanism and a sophisticated ghost cult (Anderson 1981; Larsen and Rainey 1948: 149; Mason 2009: 85; Mason 1998: 273).

The Ipiutak occupation at Cape Espenberg does not appear to be very extensive; a small number of shallow houses appear to have Ipiutak lithics but no

elaborate artwork. A single Ipiutak occupation at Cape Espenberg has been dated to *ca.* 1300 yrs. BP (Harritt 1994: 245). The Ipiutak people seem to have had only one, short-term occupation at Cape Espenberg, followed by yet another gap in the occupation of the area (Mason and Gerlach 1995b: 116).

After the Ipiutak occupation of Cape Espenberg, there are few sites that definitively date from between 1180 and 800 cal. yrs. BP– the earliest limit of Western Thule occupation (Mason 2009: 116). Between the oldest Thule ridge and the youngest Ipiutak ridge, even after intensive surveying, no archaeological features were found on this ridge (Mason et. al. 2007). There appears to be a true occupational hiatus around this time.

After 800 cal. yrs. BP, Cape Espenberg seems to have become a very attractive location for settlement. Thule sites extend longitudinally across the spit for hundreds of meters (Mason 2009: 116), suggesting a dense Thule occupation (Mason and Bowers 2009: 33). Later than *ca.* AD 1700, however, there are very few Thule houses (Mason and Gerlach 1995b: 117), and the spit appears to have been largely abandoned (Mason 2009: 116). This suggests that Cape Espenberg – unoccupied from about AD 1900 onwards – began to depopulate about 200 years before its ultimate abandonment (Burch 1998: 287).

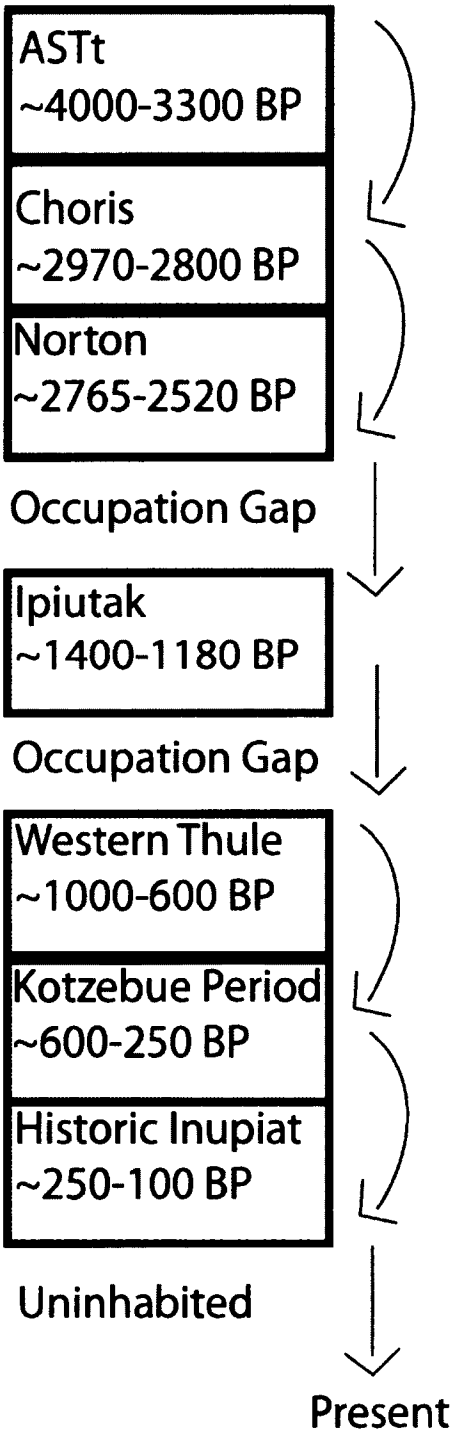


Figure 2.2: History of Human Occupation at Cape Espenberg.

The first historical account of inhabitants at Cape Espenberg and the surrounding Goodhope region (see Figure 2.3) comes from Otto von Kotzebue when he observed locals from their ships while sailing the shores in 1816 (Burch 1980: 288; Burch 1998: 287; Ray 1984: 299). Frederick W. Beechey contacted the inhabitants of the region in 1826, followed by the Franklin expedition in 1854. In the latter two cases, only a few individuals were encountered (Burch 1998: 287). Burch (1998, 2006) identifies the inhabitants from these explorers' accounts as being members of the *Pittagmiut* nation. Dorothy Jean Ray (1975) also attests to the existence of this historic Inupiat nation, which she calls the Buckland tribe, occupying the Goodhope region. This Inupiat nation is the most enigmatic and least known of all the historic nations of Northwest Alaska. It seems to have ceased to exist as an independent nation by the 1880's. By 1910, only one remaining *Pittagmiut* individual remained in the Goodhope district (Burch 1998: 285-287, 296).

Little is known about the *Pittagmiut* (Burch 1980: 288; Schaaf 1996: 44). From what information exists, it seems that their yearly cycle was as follows. At freshwater freeze-up, the *Pittagmiut* lived in medium sized villages along the Kugruk, Imnatsiaq and Goodhope rivers. During the winter they lived on fish, caribou and small game. With the return of spring, the *Pittagmiut* would all travel to Cape Espenberg to hunt seals. When the sea ice left in late June or early July, a few families would travel to the fair at Sisualik, but most would return to the rivers to fish. Later in the season, they would venture inland to hunt caribou, and then return

to the coast to catch seals before moving to their winter settlements (Burch 1980: 288).

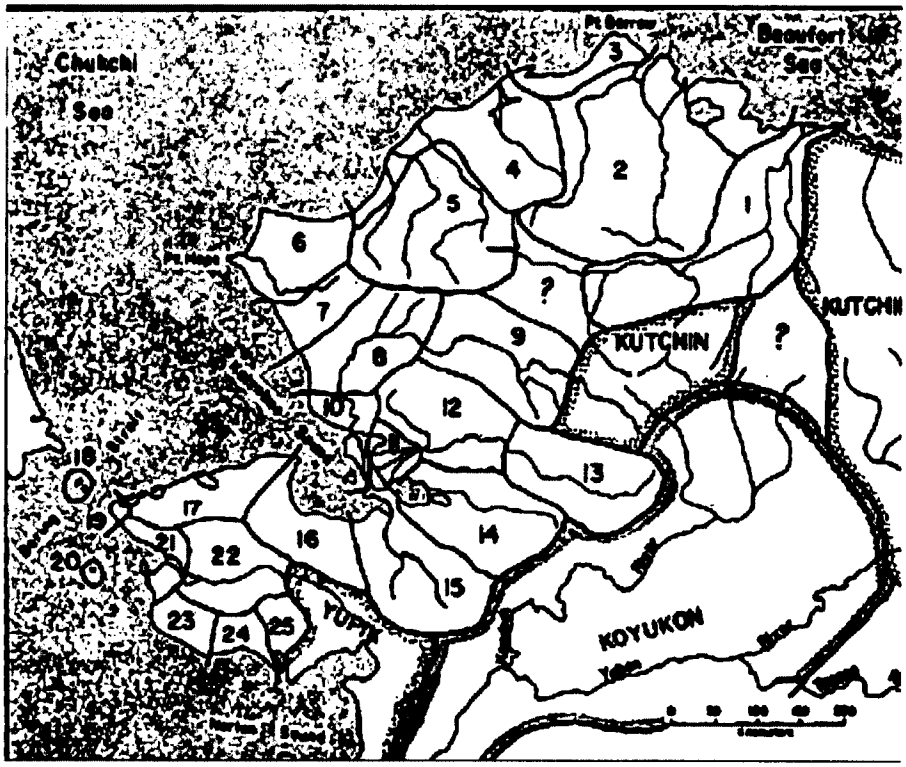


Figure 2.3: Inupiat Nations from Burch 1980: 261 (16 is the Goodhope District).

Ultimately, the reasons for Cape Espenberg's ultimate abandonment by the *Pittagmiut* remain unknown. There is no evidence that there was any sort of famine or other acute disaster that would have motivated a large-scale movement of *Pittagmiut* people. In the words of Burch (1998: 303), the *Pittagmiut* seem to have simply "disappeared." There is evidence that by the 1700's, boundaries between various Inupiat nations had become destabilized as people began to move in an

effort to gain control over scarce and valuable European trade items (Schaaf 1996: 47).

A lack of sufficient woody fuel resources may have also been a factor in the abandonment of the area (Clifford Weyiouanna 2010, personal communication). As stated previously, having a reliable source of fuel was just as critical to survival as was having enough food (Burch 2006: 52). Today, driftwood is not very abundant along the beaches of Cape Espenberg, and there does not appear to be enough driftwood today to support what appears to be intensive wood use seen in Thule houses at Cape Espenberg. It is thus possible that driftwood supplies were more abundant in the past.

Today, some families travel to the area on a seasonal basis for hunting, clam harvesting, or berry picking, but there are no permanent settlements (Wisniewski 2005). Based on the past patterns of settlement and depopulation in the archaeological record, it seems that Cape Espenberg has probably always been an area that was more or less attractive depending on resource availability, population fluctuations, climatic variables, and other social or cultural factors.

The Beach Ridge Sequence at Cape Espenberg

The tall, numerous and sandy beach ridges make Cape Espenberg distinctive. Owen Mason, in his 1990 dissertation, demonstrates that the sand dunes at Cape Espenberg provide valuable information about previous climatic conditions and the construction of the spit itself. Over the past 5,000 years, Cape Espenberg has

prograded seaward more than 2 km, forming some 16 beach ridges parallel to the shore. Each of these ridges ranges from less than 1 m in height, to over 10 meters. The highest dune ridges are typically the ones closest to the modern shoreline – except for the western ridges (Mason 1990).

These sandy dunes were formed during periods of time when intense storms and winds deposited large amounts of sand on to the beach. Between the elevated dunes are low, swampy, wet swales. The width of these swales indicates that storminess at Cape Espenberg varied between the depositions of each of the discrete ridges. Storm intensity and frequency appears to have increased between 3300 and 2200 cal. yrs. BP - depositing earlier ridges - and from 1200 cal. yrs. BP to the present, depositing the Thule and younger ridges (Mason 1990: 119).

As defined by Mason (1990) and Mason et. al. (1997) there are four units of beach ridges on Cape Espenberg. Unit I is the oldest, and was formed before 3800 cal. BP. Unit II was formed prior to 3300-2000 cal. BP, Unit III formed between 2000-1000 cal. BP, and Unit IV began forming after 1200 cal. BP, and continues to form today. Each Unit contains sub-complexes named simply A, B, C, D and E from west to east. Sub-complexes A and B are west of the Espenberg River, and C is at the middle of the spit. The sub-complexes D and E move steadily eastward (Mason 1990: 42, 67). See Figure 2.4 for a map of the progression of these ridges.

The dating of the formation of these ridges helps to provide not only a timeline of Cape Espenberg's development, but also human inhabitation. Prehistoric people were attracted to the high beach ridges for sighting game and for avoiding

storm surges (Mason 1990: 141). The date of dune formation provides information about when people could have first settled the ridge and where they were living in relation to the contemporary coastline.

This thesis focuses on Unit IV, the beach ridges Mason (1990: 96) refers to as the "Thule dunes." As stated previously, these are the most recent dunes to form on the spit. The most extensive excavations were conducted primarily on Unit IV's E-sub complex in the easternmost part of the spit. One dune, E-6a, is part of Unit III, but was also excavated in order to uncover two other house features (Mason 1990: 97-100).

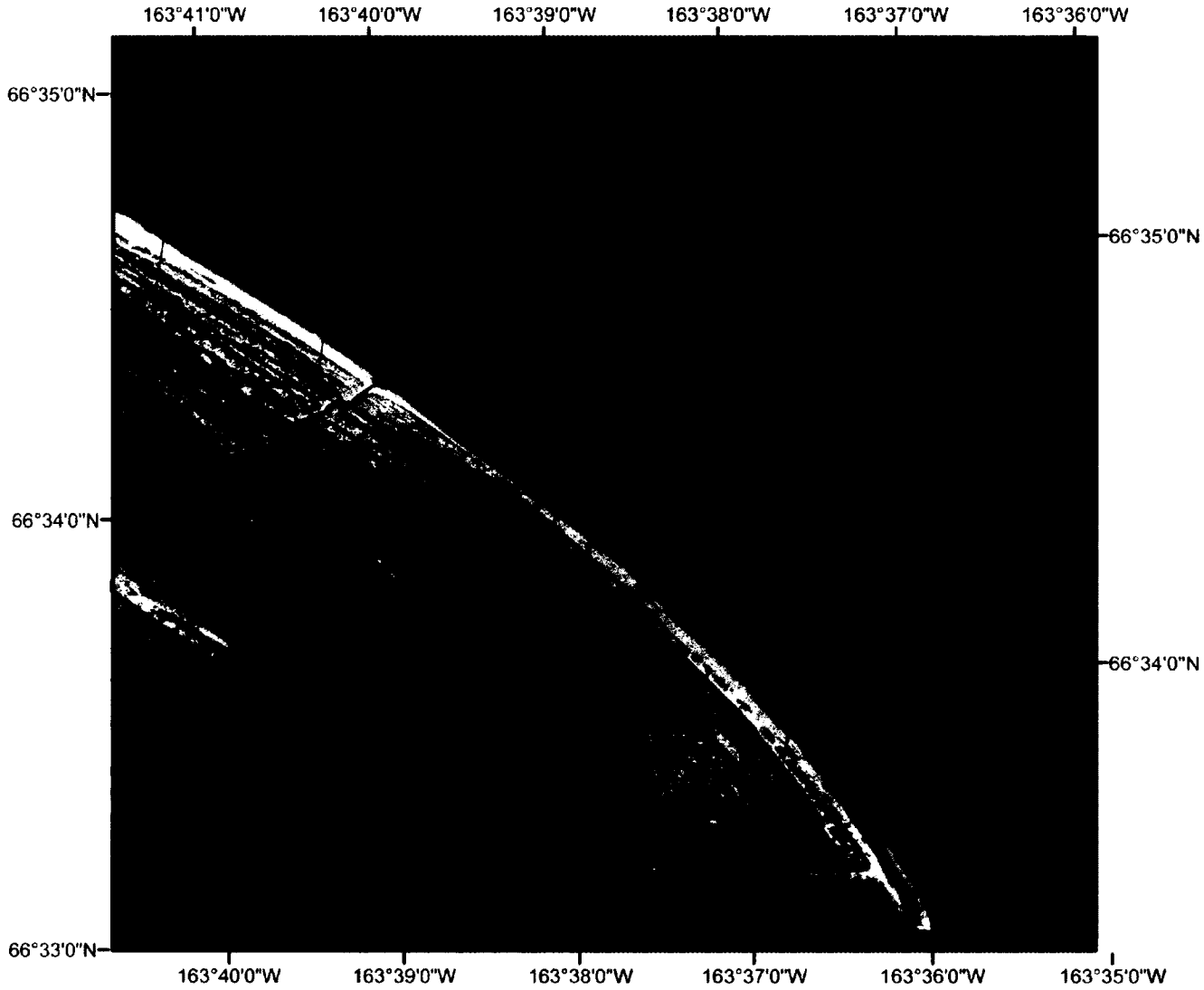


Figure 2.4: Beach Ridge Sequence (map adapted with permission from Nancy Bigelow in Hoffecker and Mason 2011. Data from Mason 1990).

Past and Present Research at Cape Espenberg

James-Louis Giddings was the first archaeologist to conduct research at Cape Espenberg in 1958 and 1960. He did not comment on the younger, Thule ridges except to say, "with the exception of a possible Ipiutak site...the only other sites observed were fairly recent structures" (Giddings and Anderson 1986: 85). He, like other archaeologists of his time, believed that the sandiness of the spit and the shallowness of the surrounding waters made Cape Espenberg an unpromising locale for finding archaeological remains. He noted a few house features and artifact scatters, but largely passed over the area in favor of Cape Krusenstern to the north (Giddings 1967: 20-26).

Archaeological work at Cape Espenberg did not truly begin until the Bering Land Bridge National Preserve (BELA) was created in 1980 (Schaaf 1988). Cape Espenberg was included as part of this 2,457,000-acre preserve. As mandated by the National Historic Preservation Act, a BELA Cultural Resources Inventory was carried out to record the cultural resources of the new national park, and to designate those resources that needed protection or management. In 1985 and 1986, Jeanne Schaaf conducted a survey of the parklands. Cape Espenberg, it follows, was officially surveyed for the first time. At this time, Schaaf (1988) discovered 76 sites dating from the early ASTt, to the historic Inupiat. With diagnostic artifacts types and the use of radiocarbon dating, Schaaf (1988) determined that no sites could be definitively assigned to Ipiutak (Schaaf 1988: 188), although Ipiutak sites were rediscovered later.

Following Schaaf, Roger Harritt conducted archaeological work at Cape Espenberg. In his visits to the spit in 1988, 1989 and 1990, Harritt tested some of the sites identified by Schaaf (Harritt 1994: 59, 68). Harritt also recorded Choris, Denbigh, Norton and Ipiutak remains and dwellings, as well as extensive Western Thule and late Prehistoric remains. The sites he dated range from as old as 4,000 cal. years BP to essentially modern, historic-era Inupiat (Harritt 1994: 141).

Around the same time Harritt was working at Cape Espenberg, Mason conducted his dissertation research on the beach ridge complex, focusing on geomorphology and climatic information that can be obtained from the dunes. Specifically archaeological endeavors at the spit were not again undertaken until 2007. In 2007 and then from 2009-2011, archaeological excavations took place at Cape Espenberg as part of the large, present, interdisciplinary, NSF-funded project Cape Espenberg project (CEP) of which this thesis is a small part.

During three field seasons, six house features were either fully or partially excavated on ridges E-4, E-5 and E-6 (Figure 2.1). Additionally, a number of test pits were dug in various locations on the spit in order to establish a firmer chronology and geomorphic history of the peninsula.

Ridge E-4 contains site KTZ-088, and is the youngest beach ridge considered in this study (see Figure 2.1). Ridge E-4 is dated to from between and 379 cal. years BP and 672 cal. years BP from both geomorphic and archaeological contexts. Ridge E-5 contains site KTZ-087, and is older than ridge E-4. The five dates, geomorphic

and cultural, taken from this ridge average out to 735 ± 37 years BP (Mason 1990: 235; Hoffecker and Mason 2008). (See Table 2.2)

Ridge E-6 is older than E-5, and significantly lower than the other two previous ridges, only reaching a height of 3 m above the surrounding marshy swales. For comparison, ridges E-4 and E-5 are up to 6 m high (Mason 1990: 51). Ridge E-6 belongs to the older Unit III ridge complex, and seems to have been formed during a period of less stormy conditions. Ridge E-6 was not dated as part of Mason's (1990) dissertation, but from an archaeological site KTZ-304 that has been dated to AD 1160-1290, it can be estimated that it formed sometime around 660-790 cal. years BP (Hoffecker and Mason 2008: 4).

Table 2.2: Dates of Excavated Ridges (Mason 1990, Hoffecker and Mason 2008)

Ridge	E-4	E-5	E-6
Date	379-672 cal. yr. BP	735 ± 37 cal. yr. BP	660-790 cal. yr. BP

Of the excavated house features, KTZ-087 Feature 87 on Ridge E-5 was previously tested and dated by Roger Harritt in 1988. Harritt's excavation was reopened and expanded in 2009, and the house feature was excavated in the summer of 2011. KTZ-088 Feature 33 on Ridge E-4, KTZ-087's Features 68A and 68B – two neighboring house structures further east on Ridge E-5 – and KTZ-304's Features 12a and 21 on Ridge E-6 were excavated in the summers of 2010 and 2011. Two of the three houses excavated during the 2010 season, Feature 33 and

Feature 68a, are the focus of the present study, although KTZ-304 Feature 21 is considered briefly. See Figure 2.1 for the location of these house features.

KTZ-088 Feature 33, KTZ-087 Feature 68a and KTZ-304 Feature 21

KTZ-088 Feature 33 is the youngest of all the house structures excavated for the Cape Espenberg Project. Feature 33 has been dated on a caribou bone to the relatively recent date of 120 ± 40 C-14 years BP (Beta-286171) calibrated to 280 – 0 BP (two standard deviations). There are no historic era artifacts such as glass beads, ammunition shells or other Western accoutrement. The absence of such artifacts suggests that the house was occupied prior to Western contact, probably sometime during the late 17th century or the early 18th century.

Feature 68a was also dated on a caribou bone to an older date of 250 ± 40 C-14 years BP (Beta-286172), calibrated to two standard deviations to 430 – 0 years BP. A second date from Feature 68a dated on a caribou bone yielded a date of 360 ± 40 BP, calibrating to 510 – 310 BP. Both dates place this house within the earlier Kotzebue Period or Late Thule Period. Table 2.3 summarizes the house feature dates.

Table 2.3: House Feature Dates

	Lab Number	Date	Calibration (2 sigma)	Material
KTZ-088 F. 33	Beta-286170	120 ± 40 BP	280 - 0 BP	Bone Collagen
KTZ-087 F. 68a	Beta-286171	250 ± 40 BP	430 - 0 BP	Bone Collagen
KTZ-087 F. 68a	Beta-286172	360 ± 40 BP	510 - 310 BP	Bone Collagen

Both Features 33 and 68a are semi-subterranean sod and wood constructed structures that were likely winter houses. They were selected for study because both houses were intact, undisturbed and relatively well preserved. Each house had an obvious entry tunnel, a main living area where there would have originally been a sleeping platform, and a burnt feature, which may or may not have been associated with the occupation of the house. The preservation of these different areas allows investigation of discrete activity areas, and the comparison of similar contexts from each house. Furthermore, both houses date to a different time period, making it possible to investigate temporal differences between each dwelling.

KTZ-088 Feature 33

There are some differences between Features 68a and 33 that deserve mention. Figure 2.5 is a map of Feature 33 created by John Darwent of U.C. Davis, and shows all of the features mentioned in this following section. Firstly, Feature 33's tunnel is constructed with a series of upright wooden posts with a single, finely hewn, driftwood timber for the floor. The tunnel of Feature 33 faces north, towards the Chukchi Sea, and has a very obvious cold trap that leads into the main living area of the house. Figure 2.6 shows the tunnel floor of Feature 33.

The living area of Feature 33 also had a fine, well-preserved wooden floor (see Figure 2.7), and a ceramic lamp found *in situ* with a spoon-like antler stirring tool (see Figure 2.8) that was probably used for maintaining the oil lamp fire. There are the remains of a sleeping platform at the back of the living area room, but it

appears that the timbers were removed at some point, perhaps to be re-used elsewhere.

The burnt feature, Feature 33-1, does not seem to be connected to the house via the tunnel. The amorphous shape, and lack of obvious structural timbers raise questions as to whether or not it was associated with the habitation of Feature 33. This burnt feature, however, is roughly level with the main room of Feature 33, which may support association. The function of this burnt feature is unclear. It does, however, contain high concentrations of marine mammal oil cemented sand (clinker), charcoal, and small calcined bones. These clues point to F-33-1 being used as a hearth, but its ultimate function remains unclear.

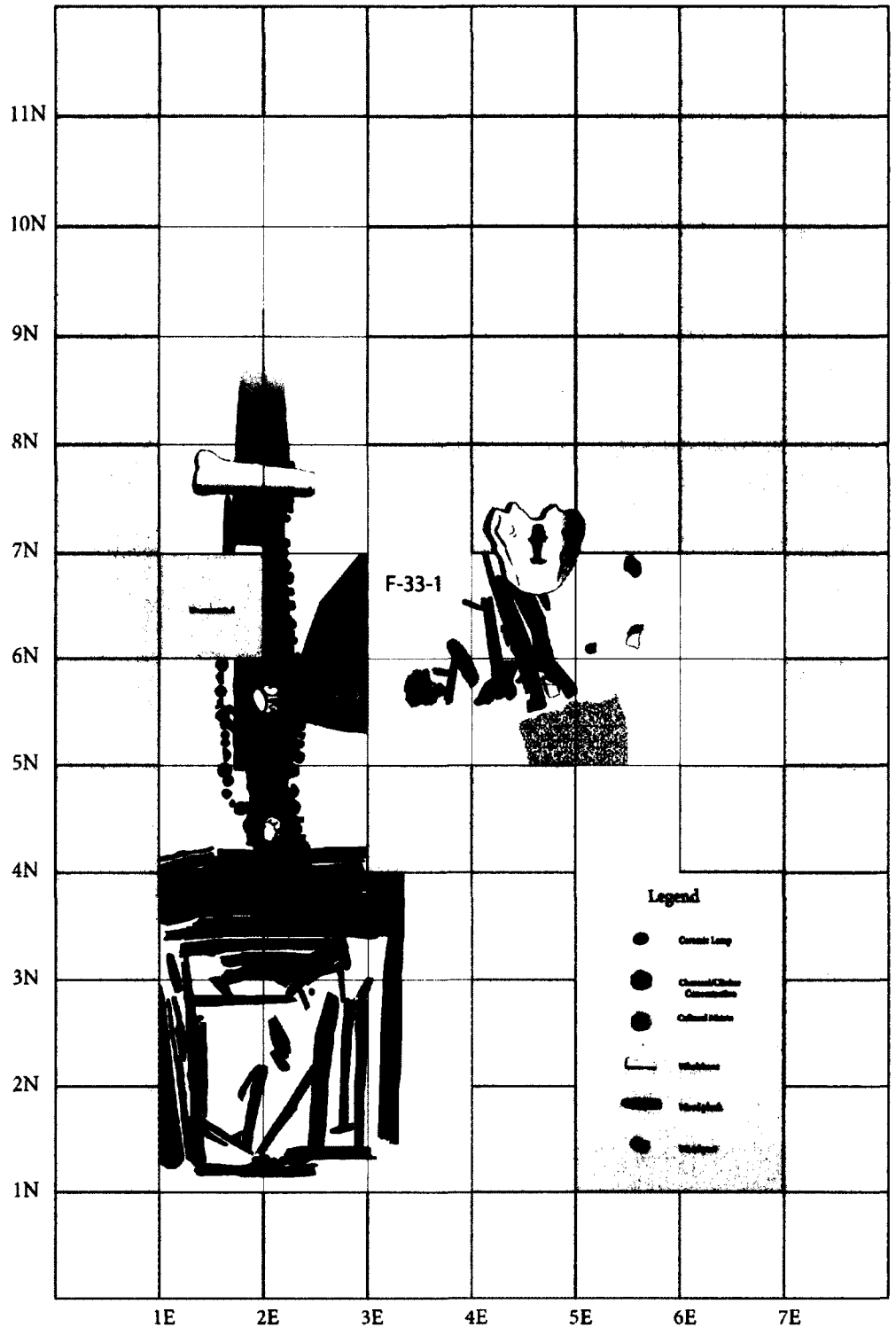


Figure 2.5: KTZ-088 Feature 33 showing all levels (Unpublished map adapted with permission from John Darwent 2010).

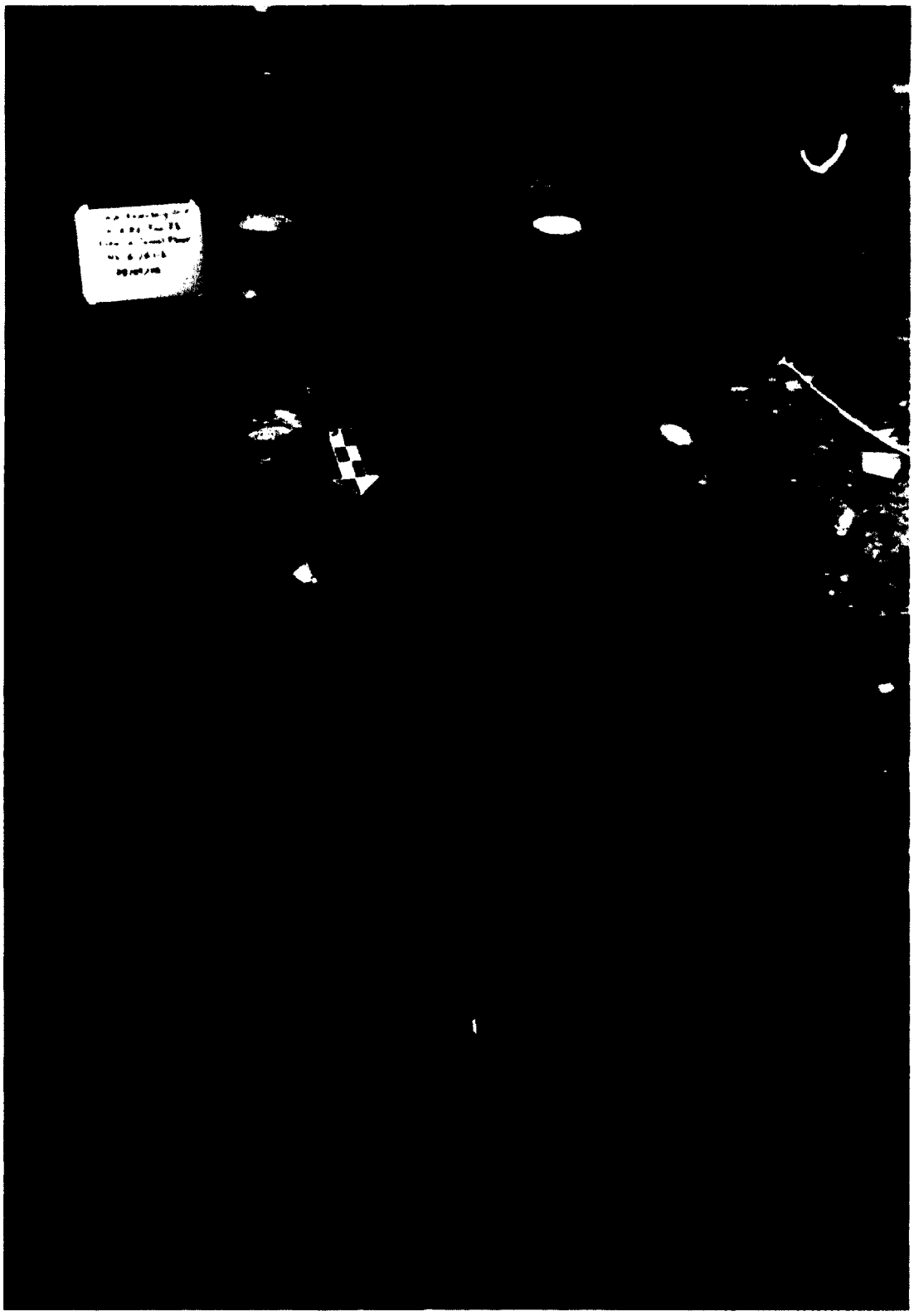


Figure 2.6: Feature 33 Tunnel Floor (Project photo used with permission by Fred Dussault).

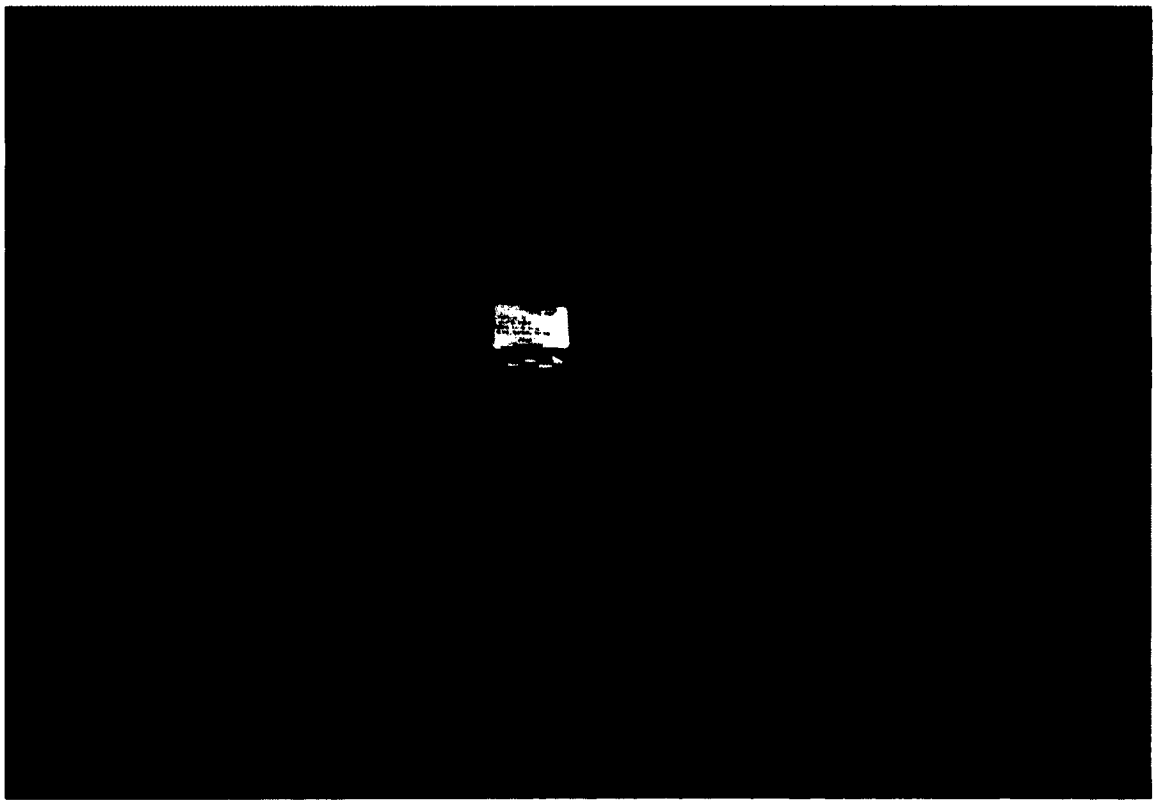


Figure 2.7: Feature 33 Living Area Floor (Project photo used with permisson by Fred Dussault).

Figure 2.8: In situ ceramic lamp with antler stirring tool in Feature 33 (Photo used with permission by Zoë Stachel)

KTZ-087 Feature 68a

Feature 68a differs from Feature 33 in several ways (see Figure 2.9). Unlike the tunnel of Feature 33, the tunnel of Feature 68a faces southeast towards the Kotzebue Sound. Why the tunnels of these house features are oriented opposite one another is unknown, but it could indicate that there were changing climatic conditions, or cultural preferences that shifted between the habitation of Feature 68a and Feature 33.

The tunnel of Feature 68a is different from the tunnel of Feature 33 in other ways as well. For one, it is very long – nearly six meters in length. Instead of being constructed with consecutive upright posts, the tunnel was constructed with long, horizontally stacked timbers. Furthermore, the tunnel of Feature 68a appears to have a dirt floor (see Figure 2.10). Also, notice that there is a clearly noticeable break in the tunnel of Feature 68a. This can be seen easily on the right hand side of Figure 2.10. This shift is also reflected in the stratigraphy of the site, and may have been the result of earthquake activity. Finally, the cold trap in Feature 68a was far less obvious than it was in Feature 33, although its function was the same.

Another defining characteristic of Feature 68a is its depth. The occupation level of Feature 68a was as deep as two meters below the surface in some locations. The occupation level of Feature 33 is closer to 1.5 meters in depth. The main living area of Feature 68a also appears to have had a wooden floor, and a sleeping platform at the back. Not all of the living area of Feature 68a was excavated, however, and its delineating boundaries are unknown. Figure 2.11 shows what was

excavated of the living area. So, unlike in Feature 33, the living area of Feature 68a did not yield an oil lamp. It is possible, however, that the lamp of Feature 68a could be waiting still in an unexcavated portion of the house.

Also, while the burnt area of Feature 33 has an unclear association with the rest of the house, the association of the burnt area of Feature 68a is even more questionable. Feature 68a-1 is significantly higher than the occupation floor of Feature 68a, making it unlikely that it was associated with the main occupation of the house. This burnt feature too contained high amounts of charcoal, clinker and calcined bone, but also contained a possible fired clay feature. It is possible that Feature 68a-1 may have been used in ceramic production, and/or as something akin to a summer hearth.

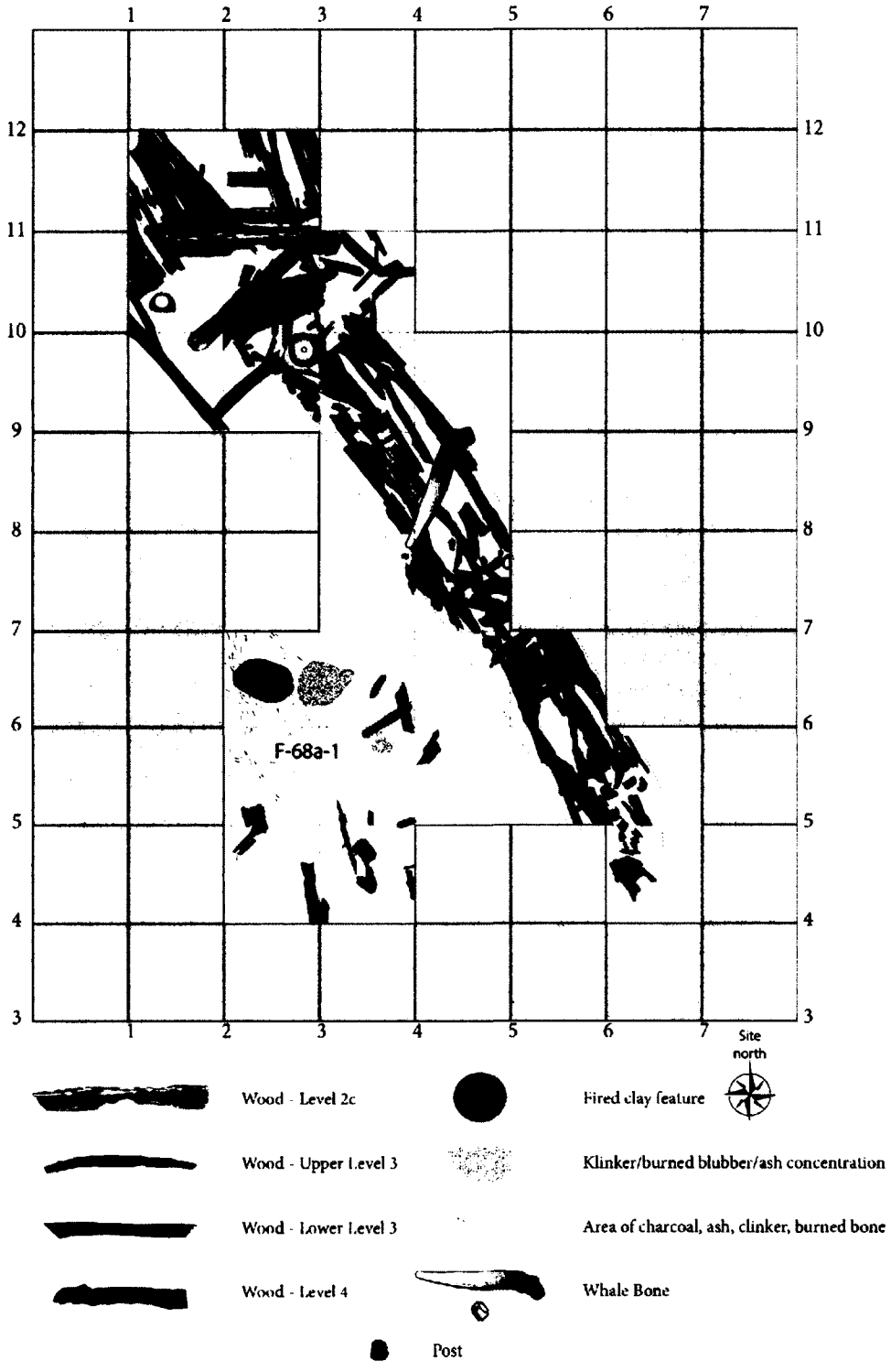


Figure 2.9: KTZ-087 Feature 68a showing all levels (Unpublished map used with permission by John Darwent 2010).

Figure 2.10: Feature 68a Tunnel Floor (Project photo used with permission by Fred Dussault).

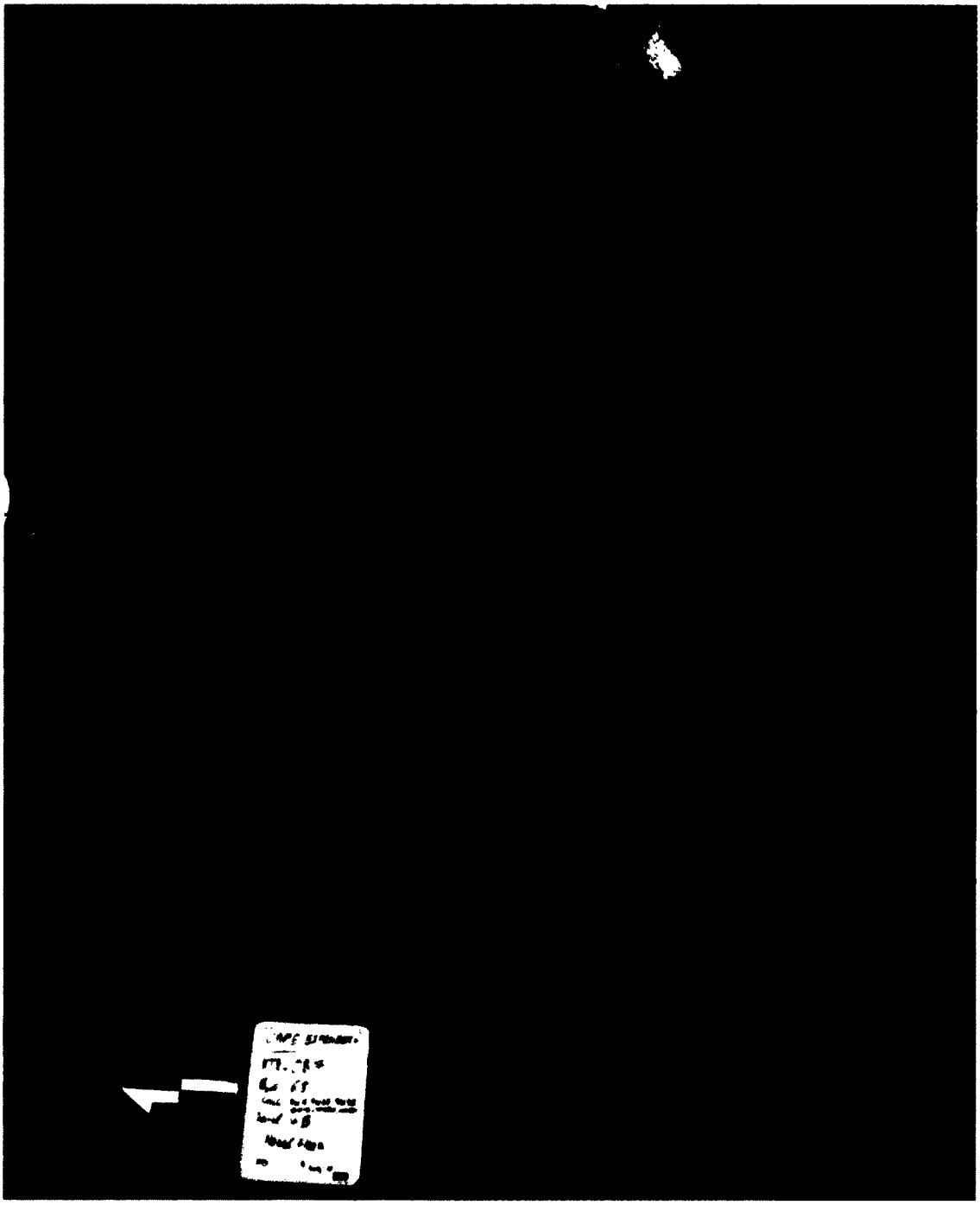


Figure 2.11: Feature 68a Living Area Floor (Project photo used with permission by Fred Dussault).

KTZ-304 Feature 21

House Feature 21 is the oldest site excavated during the 2010 field season. On the basis of surface depression patterns, it is thought that this house has two rooms – a north room that appears to have been the main living area, a south room that may have been a hearth feature of sorts, and an entrance tunnel facing north. This feature was partially excavated, but was abandoned partway into the roof-fall layer due to the discovery of human remains. The occupation level of this house was not reached (Hoffecker and Mason 2010).

Chapter 3: Methods

An Introduction to Anthracological and Macrobotanical Methodology

Charcoal Analysis

Anthracology, the analysis of archaeological charcoal fragments can provide information about firewood management. It shows what species were being selected and used for fuel (Dufraisse 2006: 48; Hastorf 1999: 62), but also provides evidence of what woody resources were available in an area (Marguerie and Hunot 2007: 1417). Charcoal remains not only originate from wood collected and burned as fuel, but also from discarded wooden tools and dismantled construction materials (Pearsall 1988: 100).

In studying prehistoric charcoal assemblages, some archaeologists assume that fuelwood gatherers could and did differentiate between different woody taxa, and selected them according to their known energetic properties. This may have involved a consideration for energetic costs in gathering wood, and making it into a useable form (Deo-Shaw 2008: 97). The decision to use a particular type of wood for fuel depends upon a number of the wood's physical characteristics, including its heat and smoke output (Smart and Hoffman 1988: 168).

Smaller pieces of wood serve as kindling to start a fire, whereas larger pieces of wood are used to maintain a fire (Smart and Hoffman 1988: 169). The diameter of the original stem or branch used in a fire can be estimated from charcoal fragments that have both bark and pith (Marguerie and Hunot 2007: 1418). Even without bark

and pith, under certain conditions, it is still possible to estimate diameter (Chrzavzez 2006: 36). Charcoal with a weak curvature likely comes from a tree trunk, while charcoal with strong curvature likely come from branches or twigs, although it could also come from the inner part of the tree (Marguerie and Hunot 2007: 1421). Marguerie and Hunot (2007: 1421) separate growth ring curvature into strongly curved rings, moderately curved rings, weakly curved rings (in cases where the rings seem to be straight, or parallel to one another), and fragments with indeterminate curvature, in order to determine what parts of a tree were being used for fuel.

For charcoal fragments that have both bark and pith, it is possible to measure the angle of the rays and determine the diameter of the stem or branch from which a fragment originated. In order to do this, however, it is necessary to consider the amount of size reduction of charcoal fragments due to combustion (Marguerie and Hunot 2007: 1418). This is a difficult process, and was not done for this thesis. It is important to mention, however, that it is indeed possible to calculate the original diameter of a branch, twig or trunk from charcoal fragments.

In an archaeological site, charcoal must be sampled from all cultural contexts. The wood used in domestic fires is more likely to represent a random sample of the vegetation and fuelwood use over a short period of time – the last time or few times the hearth was used. Charcoal dispersed throughout the occupation levels better represents longer-term fuelwood use. Charcoal fragments within a house probably

represent the remains of multiple firings of a hearth, or woody fuel use over a longer period of time (Heinz and Thiébault 1998: 57).

Archaeologists collect large pieces of charcoal found during excavation, but recover most charcoal through water screening or flotation (Smart and Hoffman 1988: 173). Gathering only large pieces of charcoal provides a biased sample. Systematically recovering charcoal provides a more representative, unbiased sample. Flotation and water screening are the preferred methods for charcoal recovery.

In reality, the samples taken from a site only represent a very small portion of what was excavated. With very few exceptions, samples are processed only to recover charred plant material (Smart and Hoffman 1988: 173). Time and cost constraints often prevent the analysis of all archaeobotanical samples taken from a site. Furthermore, not all of the charcoal recovered from an archaeological site can be analyzed. When a macrofossil sample contains large amounts of charcoal, subsamples of charcoal pieces are chosen for identification (Smart and Hoffman 1988: 174). If sampled and sub-sampled properly, charcoal remains can help enrich the archaeological interpretation of a site.

Macrofossil Analysis

Like most studies on macrobotanical remains, time and cost constraints prevented the analysis of all of the plant material recovered from the sites at Cape Espenberg. The original assemblage itself is imperfect, and is biased by both known

and unknown factors such as deposition, preservation and recovery – especially since different plant remains and different plant parts have different likelihoods of being preserved in archaeological contexts (Johannessen 1988: 145, 155).

At most sites, seeds and other plant remains are preserved only if they are carbonized. Only in unusual circumstances do plant remains survive without carbonization. Cape Espenberg is one unusual exception in that it has good plant preservation even without carbonization. The part of a plant most likely to be preserved in an archaeological context, carbonized or not, are seeds. Seeds are often robust and the most easily recovered and identified plant part (Pennington and Weber 2004: 14).

Context is crucial for interpreting plant remains (Pennington and Weber 2004: 15). For plant macrofossil studies, it is important to compare plant material from inside archaeological features to adjacent contexts. This significantly strengthens any conclusions concerning plant deposition, and can also help to reveal unique characteristics in cultural contexts that would not otherwise be detected. This cross-comparison also helps to prevent spurious conclusions about the plant remains found in a certain context or feature (Lennstrom and Hastorf 1995: 716). In order to achieve a firm grasp on stratigraphical and contextual differences, blanket sampling within a site is key (Lennstrom and Hastorf 1995: 717).

When analyzing plant remains, it is important to standardize sample sizes – especially if the analyst is planning to do any sort of statistical analyses (Hastorf

1999: 58). Standardization allows for the determination of the richness of a sample, and also allows the contents of different sized samples be properly compared.

Conducting measures on the presence of a taxon in each 1 x 1 m square is especially useful in macrobotanical studies (Pearsall 1988: 102). To do this, the number of identified plant remains is quantified (Hastorf 1999: 58). In this thesis, plant remains consisted primarily of seeds and leaves. In counting these remains, contexts can be numerically compared and contrasted against one another in meaningful ways.

Ultimately, plant processing is the most common activity represented by plant remains. It is difficult to determine the specific behaviors or activities being carried out at the site. This is due to the fact that many processing activities are complex, but also because a series of different plant processing activities could have occurred in the same location (Hastorf 1999: 75). Still, with proper sampling techniques, macrobotanical analysis can provide important information about plant use practices within a site.

Field Methods

Sampling

In 2010, for house Features 33 and 68a, sampling varied according to context and level. The layer immediately below the sod layer was considered fill, and called Level 1. In Features 33, 68a and 21, each arbitrary 10 cm level below level 1A, was assigned a letter (e.g. 1A, 1B and so on). In level 1A, a liter of soil sediment was taken from each 1 x 1 meter unit. For the rest of Level 1 (Levels 1B, 1C and so forth),

samples were randomly selected. From each randomly selected meter squared unit, about one liter of sediment was sampled. These fill samples were collected as a way to detect higher cultural levels as well as to compare against cultural samples.

Upon reaching Level 2, blanket sampling was practiced. One liter of sediment was sampled from each sequential 10 cm layer (labeled 2A, 2B and so forth) for every 1 x 1 meter unit. Feature 33's lowest cultural level is level 2, but in Feature 68a, there are two more levels. Level 2 in Feature 68a corresponds to the south area of the house – mainly the burnt feature, Level 3 is the removal of the roof-fall, and level 4 is the occupation level of the house in the tunnel and the main living room. Blanket sampling continued into these two levels in Feature 68a.

In all, 265 macrofossil samples were collected in 2010 from three house features. Of the 265 samples collected the 2010 season, 120 come from cultural levels, and 145 come from the overlying fill levels. From Feature 68a, 101 samples were taken, from Feature 33, 90 samples were taken, and from Feature 21, 74 fill samples were taken. No cultural samples were taken from Feature 21 because excavation was halted before reaching the floor of the house. In 2011, a total of 117 samples were collected. Of those 117 samples, 87 come from cultural contexts and 28 off-site samples were taken from 6 different test pits. A total of 382 macrofossil samples were taken in 2010 and 2011, of which 60 were analyzed for this thesis (see table 3.1).

Figure 3.1 show where cultural samples were taken in each house, indicated by gray shaded areas. Different shades of gray represent different features, as

indicated by the labels and legends. The units outlined in yellow represent where samples were analyzed.

Table 3.1: Macrofossil Samples Taken.

Cape Espenberg Macrofossil Samples		
2010		
	Cultural	120
	Fill	145
	Total	**265**
2011		
	Cultural	87
	Off-Site	28
	Other	2
	Total	117
Total for 2010 and 2011		**382**

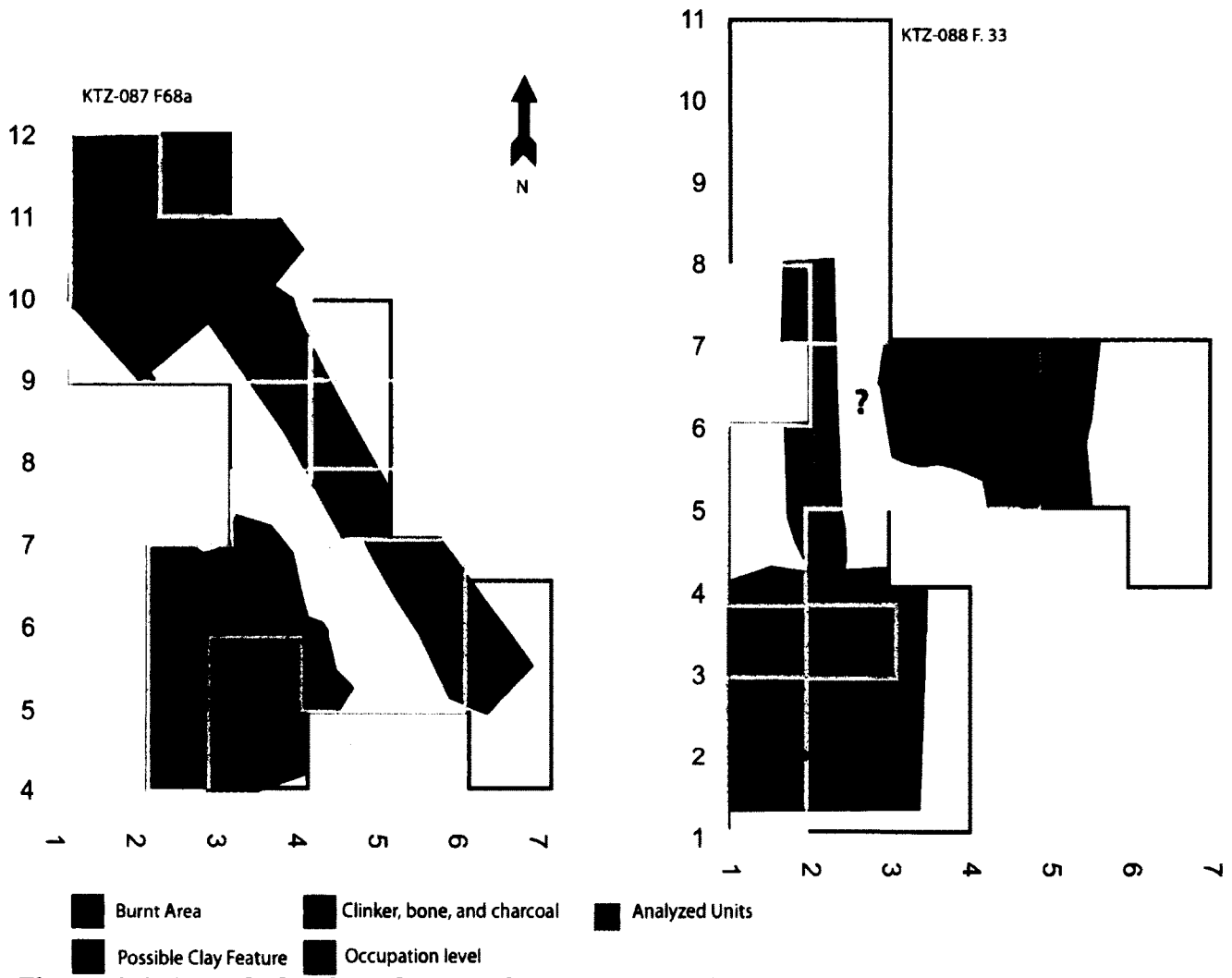


Figure 3.1: Sampled Cultural Area, all levels (The "?" indicates unclear context between tunnel and burnt area).

In the 2011 field season, eight off-site test pits were sampled. Columnar macrofossil samples were taken from the profiles of test pits 1 and 2 in 10 cm increments, e.g. 0-10 cm below surface, 10-20 cm below surface and so forth to about 120 cm below surface. A number of subjective samples were also taken from dark organic lenses (e.g. stringers, paleosols), and from pits 3, 4, 5 and 8. A subjective sample in Pit 1 was taken from below a whale skull. A total of 10 off-site samples were analyzed from test pits 1, 2, 3, 4 and 5. In total 19 liters of off-site material was analyzed for this thesis. Table 3.2 gives a complete list of the analyzed off-site samples, and the analyzed volume of each sample.

Figures 3.2, 3.3, 3.4, 3.5 and 3.6 show the stratigraphy of each test pit analyzed for this thesis. In test pits 3, 4 and 5, note the dark organic bands of buried paleosols. Also, note that the top stratigraphical layers (about the top 10 or 20 cm) are much darker than the lower layers. The dark stringers and paleosols at lower levels represent buried soils, and would typically contain more macrofossils than the purely blonde layers.

Table 3.2: Analyzed Off-Site Samples.

Test Pit	Depth	Context	Analyzed ml
1	0-10 cm	Column	170
1	10-20 cm	Column	3100
1	20-30 cm	Column	2720
1	30-40 cm	Column	3180
2	0-10 cm	Column	2720
2	20-30 cm	Column	2700
2	110-120 cm	Column	2800
3	43-45 cm	Paleosol	82
4	13-22 cm	Paleosol	138
5	40-45 cm	Paleosol	1480
Total Analyzed ml			19091

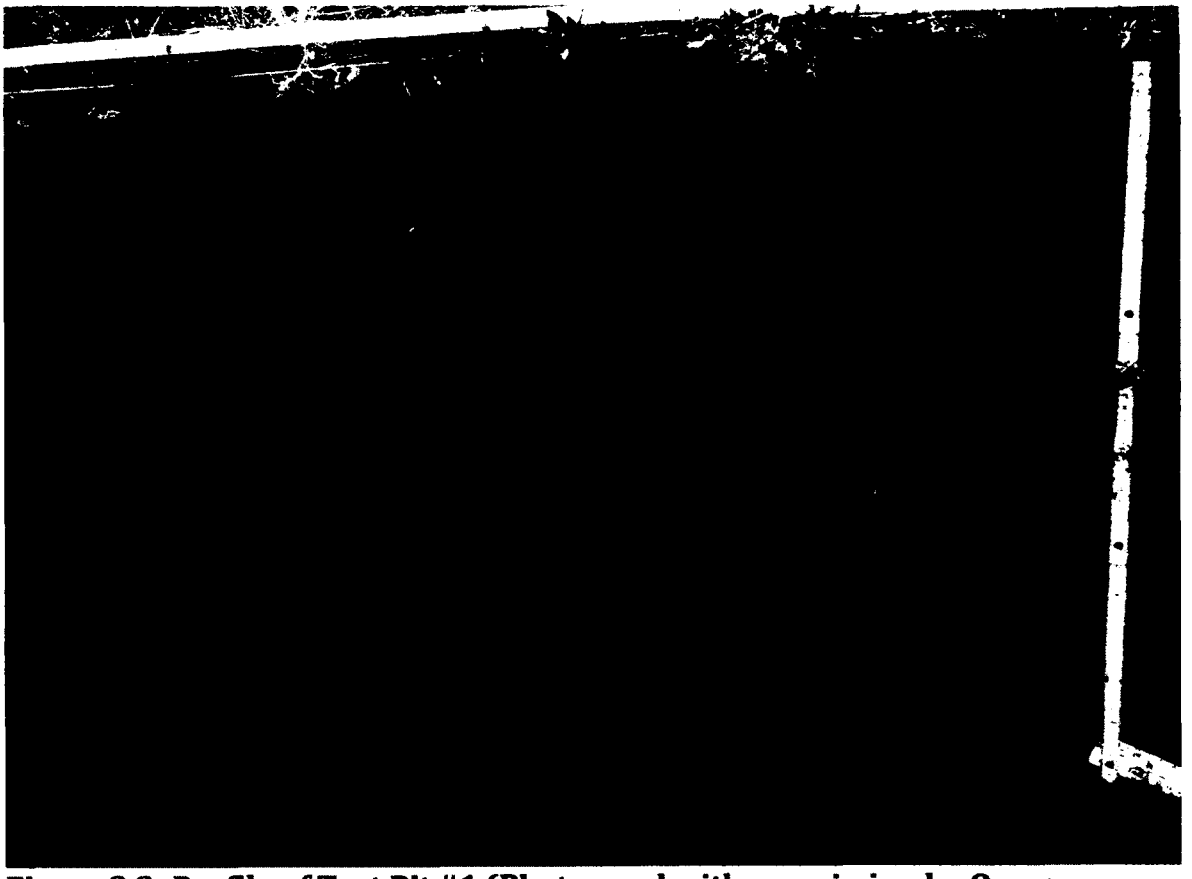


Figure 3.2: Profile of Test Pit #1 (Photo used with permission by Owen Mason).

Figure 3.3: Profile of Test Pit #2 (Photo used with permission by Owen Mason).

Figure 3.4: Profile of Test Pit #3 (Photo used with permission by Owen Mason).

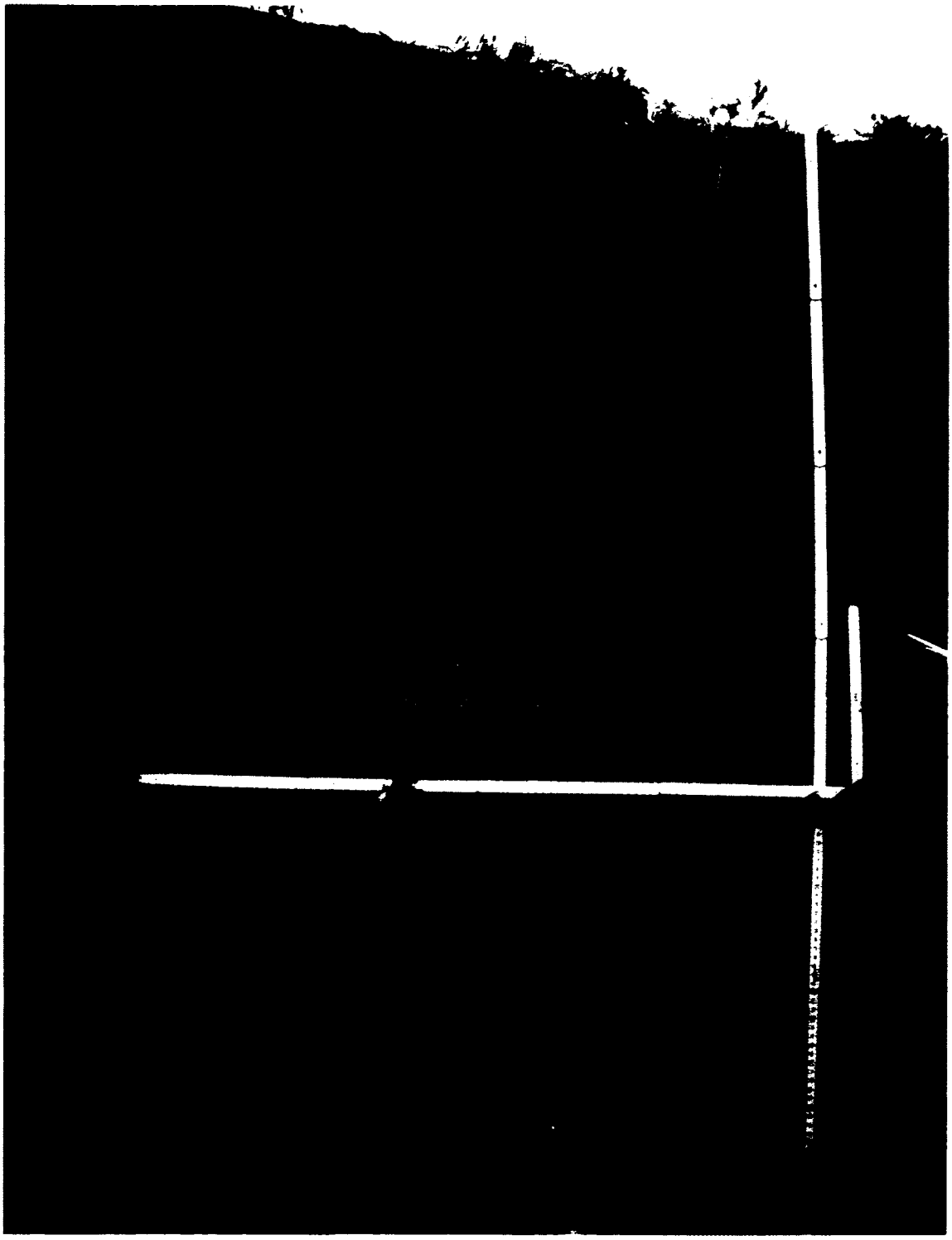


Figure 3.5: Profile of Test Pit #4 (Photo used with permission by Owen Mason).

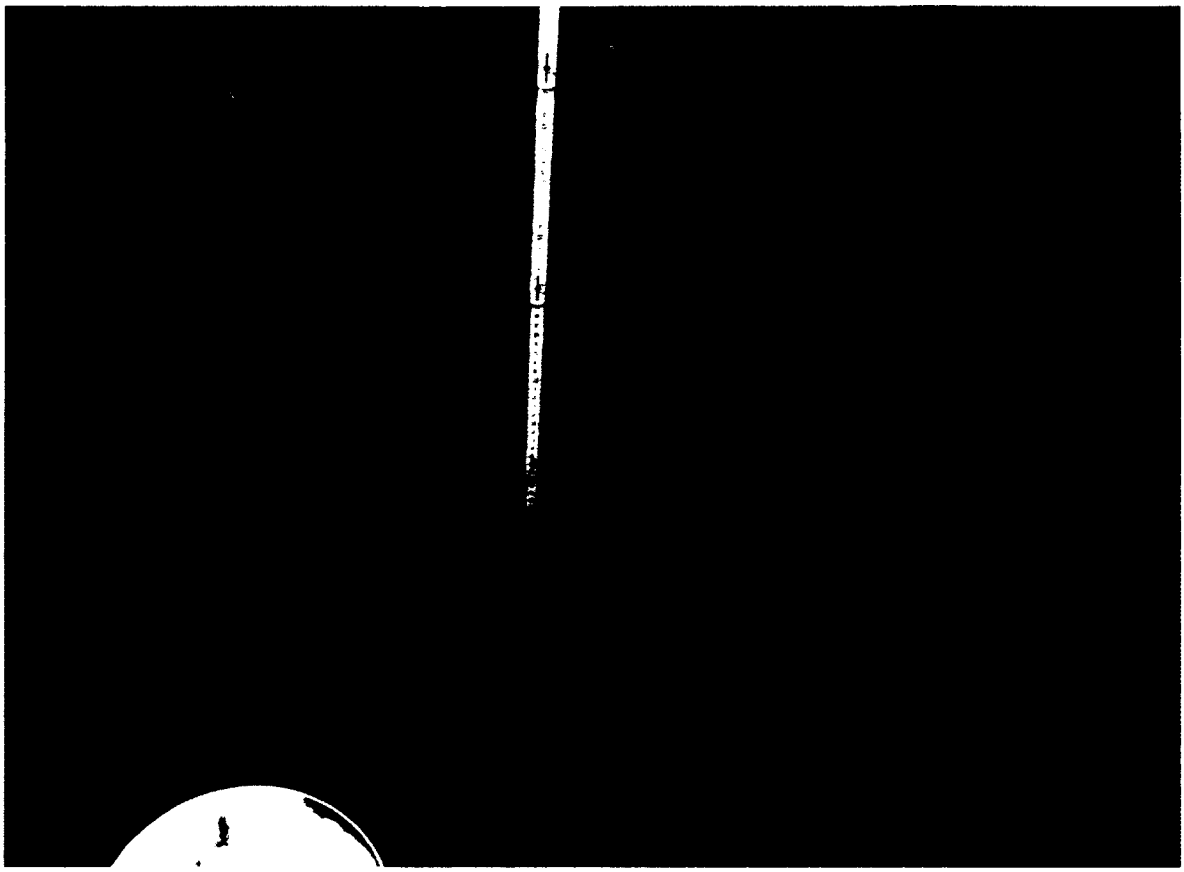


Figure 3.6: Profile of Test Pit #5 (Photo used with permission by Owen Mason).

Tables 3.3 and 3.4 provide a list of analyzed cultural samples from Feature 68a and Feature 33 and their total processed volumes. Table 3.3 shows that 11.352 liters of cultural material was analyzed from Feature 68a. Table 3.4 shows that 11.2 liters of cultural material was analyzed from Feature 33. The total volume of analyzed cultural samples for both houses is 22.5 liters.

Table 3.3: Analyzed Cultural Samples from Feature 68a.

Site	Feature	Context	Unit	Level	Processed Sample volume ml
KTZ-087	68a	F-68a-1	6N 3E	2A	500
KTZ-087	68a	F-68a-1	4N 2E	2A	250
KTZ-087	68a	F-68a-1	5N 4E	2A	500
KTZ-087	68a	F-68a-1	6N 4E	2A	500
KTZ-087	68a	F-68a-1	6N 2E	2A	450
KTZ-087	68a	F-68a-1	5N 2E	2A	550
KTZ-087	68a	F-68a-1	7N 3E	2A	300
Subtotal					**3050**
KTZ-087	68a	Living	9N 2E	3C	500
KTZ-087	68a	Living	10N 3E	4A	450
KTZ-087	68a	Living	11N 1E	4A	650
KTZ-087	68a	Living	10N 1E	4A	292
KTZ-087	68a	Living	11N 1E	4B	550
KTZ-087	68a	Living	9N 1E	4B	500
KTZ-087	68a	Living	10N 2E	4B	500
KTZ-087	68a	Living	9N 2E	4B	300
Subtotal					**3742**
KTZ-087	68a	Tunnel	6N 5E	3C	700
KTZ-087	68a	Tunnel	8N 4E	3D	1000
KTZ-087	68a	Tunnel	5N 5E	4A	910
KTZ-087	68a	Tunnel	9N 3E	4A	350
KTZ-087	68a	Tunnel	9N 3E	4D	1600
Subtotal					**4560**
Total					**11352**

Table 3.4: Analyzed Cultural Samples from Feature 33.

Site	Feature	Context	Unit	Level	Processed Sample volume ml
KTZ-088	33	F-33-1	6N 2E	2A	500
KTZ-088	33	F-33-1	5N 3E	2A	600
KTZ-088	33	F-33-1	6N 3E	2B	500
KTZ-088	33	F-33-1	6N 4E	2B	500
KTZ-088	33	F-33-1	6N 3E	2C	2000
KTZ-088	33	F-33-1	5N 1E	2E	500
Subtotal					**4600**
KTZ-088	33	Living	4N 1E	2A	650
KTZ-088	33	Living	2N 1E	2A	500
KTZ-088	33	Living	3N 2E	2A	500
KTZ-088	33	Living	4N 1E	2D	500
KTZ-088	33	Living	1N 1E	2D	500
Subtotal					**2650**
KTZ-088	33	Tunnel	7N 1E	2A	750
KTZ-088	33	Tunnel	5N 4E	2D	500
KTZ-088	33	Tunnel	7N 1E	2D	500
KTZ-088	33	Tunnel	5N 2E	2E	1200
KTZ-088	33	Tunnel	5N 2E	2E	500
KTZ-088	33	Tunnel	6N 2E	2E	500
Subtotal					**3950**
Total					**11200**

Flotation

The vast majority of these sediment samples were floated on site with a custom-made, hand-pump action flotation system designed by Shelton and White (2010) as seen in Figure 3.7. The collected light fraction was filtered through and collected in 250-micron (μ, or 1/1000th of a mm) mesh bags. Sediment samples were poured into the top tank and then agitated by hand and by pumped water from

the bottom tank, and then filtered through a 250 μ mesh screen bag attached to the spout on the top tank.

Figure 3.7: The flotation device with Rémi Méreuze using the hand pump and the author hand-agitating the light fraction (Photo used with permission by Claire Alix).

Sample volume or weight was taken prior to flotation. In 2011, for faster processing, the weight of samples was measured on a scale. These measurements provide an idea of the composition of the samples. Very light samples tended to

have the most organic material, while the heaviest samples tended to contain primarily sand, gravel and clinker. Ultimately, all weights in grams were converted to milliliters. This was done by multiplying the sediment samples' weight in grams by their densities in order to calculate their volume in milliliters.

After flotation, samples were kept in the 250-μ mesh bags, and subsequently placed in foil pouches. In 2010, only fill samples were dried while samples from contexts were kept wet inside plastic bags. Alcohol was added to cultural samples to prevent mildew growth, and because these samples were shared with Dr. Scott Elias for entomological studies. Sediment sampled from cultural floor levels were used for macrofossil and entomology research, and for this reason, they were kept wet and cool. They were frozen upon return from the field.

Lab Methods

Some cultural samples were still very large after initial field screening. These samples were water sieved again in the lab using 450 μ and/or 250 μ mesh screens. Some samples were also sieved with the aid of 5% KOH (Potassium Hydroxide) to disaggregate the samples. A measured amount of the original samples – usually about half of the original weight – was placed into a beaker, and filled with water at a 5% KOH concentration. After this, the sample was sieved and rinsed through 450 μ or 250 μ mesh screens. All samples were sieved at 250 μ; a 450-μ screen was added only when a sample was particularly rich. Adding KOH solution to a sample basically acted as a lubricant to help different components in the macrofossil sample separate

and slide apart. The KOH solution thus helped to remove sand from macrofossils in a sample, and made finding and identifying macrofossils easier.

Only a subsample of the sediment samples collected in the field were analyzed. Attention was given to specific areas within the houses – particularly the tunnel, burnt areas (F-68a-1 and F-33-1), and living room areas areas. At least one sample was analyzed from most 1 x 1 units of the cultural layer directly atop the floor planks.

As seen in Table 3.5, 60 macrofossil samples were analyzed, 37 of which are cultural. Fill samples were selected more or less randomly from Feature 33, Feature 68a and Feature 21. A total of 13 fill samples were analyzed. The fill samples taken from each house are roughly comparable because they originate from similar depths below datum, and because they all presumably originate from depressions created by the underlying collapsed house features. This assumption is tested statistically later. Table 3.5 lists each analyzed sample and its context. From these 60 macrofossil samples a total of 9, 518 individual macrofossils (listed in table 3.6) and 1,617 charcoal fragments (listed in table 3.7) were analyzed.

Table 3.5: Analyzed Sediment Samples by Context.

	Ridge 4	Ridge 5	Ridge 6	TOTAL
Context	Feature 33	Feature 68a	Feature 21	
Burnt Feature	6	7	0	13
Tunnel	6	5	0	11
Living Area	5	8	0	13
Total Cultural	*17*	*20*	*0*	*37*
Fill	4	3	6	13
Subtotal	*21*	*23*	*6*	*50*
Off-Site	3	3	4	10
TOTAL	24	26	10	60

Table 3.6: Analyzed Macrofossil Remains (Raw Counts).

	Ridge 4	Ridge 5	Ridge 6	TOTAL
Context	Feature 33	Feature 68a	Feature 21	
Burnt Feature	219	769	0	988
Tunnel	521	497	0	1018
Living Area	237	346	0	583
Total Cultural	*977*	*1612*	*0*	*2589*
Fill	1086	2271	972	4329
Subtotal	*2063*	*3883*	*972*	*6918*
Off-Site	11	1228	1361	2600
TOTAL	2074	5111	2333	9518

Table 3.7: Analyzed Charcoal Fragments.

		Site		Total
		Feature 68a	Feature 33	
Context	Burnt Feature	335	378	713
	Tunnel	294	178	472
	Living Area	198	234	432
TOTAL		827	790	1617

Microscopic Identification

Once selected and prepared, the samples were systematically analyzed under 10x to 50x magnification using transmitted light microscopes. First, samples were picked under lower magnification, closer to 10x magnification. Identifiable plant remains were counted, collected and recorded according to species, genus or family. Macrofossil identification was aided with Hultén (1968) and Katz et. al. (1965), and Schaaf's (1987) unpublished vegetation survey at Cape Espenberg. The University's reference collection of seeds and leaves was also used, as was Dr. Bigelow's plant reference collection gathered specifically from Cape Espenberg. With all of these sources at hand, most specimens could be confidently identified.

Each macrofossil sample was recorded with its macrofossil count by taxa in a Microsoft Excel spreadsheet. Hultén's (1968) nomenclature was used except where Viereck and Little (2007) have updated the tree and shrub nomenclature. Some macrofossil remains were difficult to identify, especially when dealing with fragmentary remains, or rarer specimens. For instance, it can be hard to tell Bog Rosemary leaves (*Andromeda polifolia*) apart from Labrador Tea leaves (*Ledum decumbens* or *l.. palustre*). The leaves can be differentiated based on the presence of short red hairs on the lower side, vein patterns on the surface, and the degree of reflex along the leaf margin. Oftentimes, however, the telltale red hairs are not preserved.

Some leaves – especially willow leaves – could be difficult to identify because leaf shape is variable, and generally only fragments preserved. However, the stem of

willow leaves curl inwards dramatically, making them easy to identify as long as the stem remains intact. Still other macrofossils – if they are macrofossils – were impossible to identify, such as this hard, white, spherical object with dark material inside seen in Figure 3.8. It may be a fungal resting body.

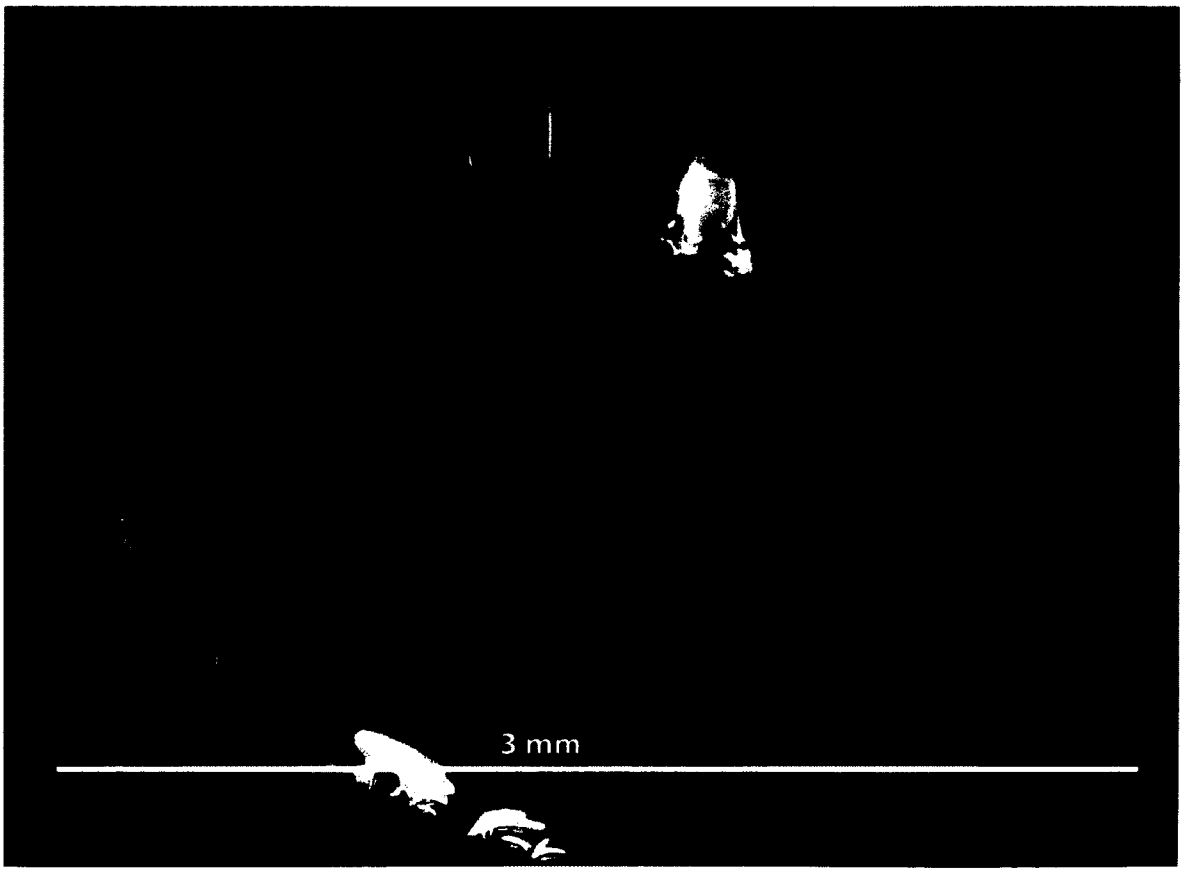


Figure 3.8: Unknown body at 50x magnification.

Other remains such as hair, caribou fur, other mammal fur, animal hide remains, calcined bones, small fish and animal bones, fish scales, shells, insects and insect parts, lithic debris, small pieces of ceramics, and wood shavings were also removed and collected. Although a tally was kept of the calcined bones found in each

sample, the other remains were noted but not counted, and were not included in the overall plant macrofossil count.

The amount of charcoal found in each sample was counted, separated, dried and collected for later identification. Following the initial picking of the samples, charcoal fragments were identified to the genus level using a reflective microscope with 10x to 50x magnification. Typically, a higher magnification was used to identify charcoal. Usually, about 50 pieces of charcoal were randomly selected and identified from each cultural sample regardless of sample size, or the number of charcoal pieces found within a particular sample.

Many samples analyzed for this thesis had large numbers of charcoal fragments (several thousand) while others had very few fragments. The number 50 was chosen because it is a sample large enough to be representative in the Arctic where species diversity is low, and because analyzing fewer charcoal fragments from each sample allowed the analysis of more samples from more contexts in a limited period of time. Claire Alix (personal communication 2012) has established that after identifying approximately 50 charcoal fragments from the Northwest coast of Alaska that the taxa diversity has been more or less established, and no new taxa are usually encountered. For Cape Espenberg, analyzing 50 fragments ensures that you have the main species present in a sample. In other locations, 50 charcoal fragments would be considered too small for results to be representative.

The genus of each charcoal fragment, its size, growth ring curvature and degree of charring was recorded in a Microsoft Excel spreadsheet. Any additional

pertinent characteristics were recorded, i.e., when charcoal appeared to be saturated with an off-white, orange or brown fat-like substance, or when the specimen appeared vitrified.

In the process of identification, charcoal pieces were broken manually to examine each of the three dimensions. Characteristics of the cross, tangential and radial sections of the wood were observed to identify charcoal remains. Figure 3.9 shows these different sections of wood (Alix 2001). The microscopic anatomy and structure of the wood observed in each of these three sections is what makes identification possible (Panshin and de Zeeuw 1980; Hoadley 1990; Benkova and Schweingruber 2004; Schweingruber 1990).

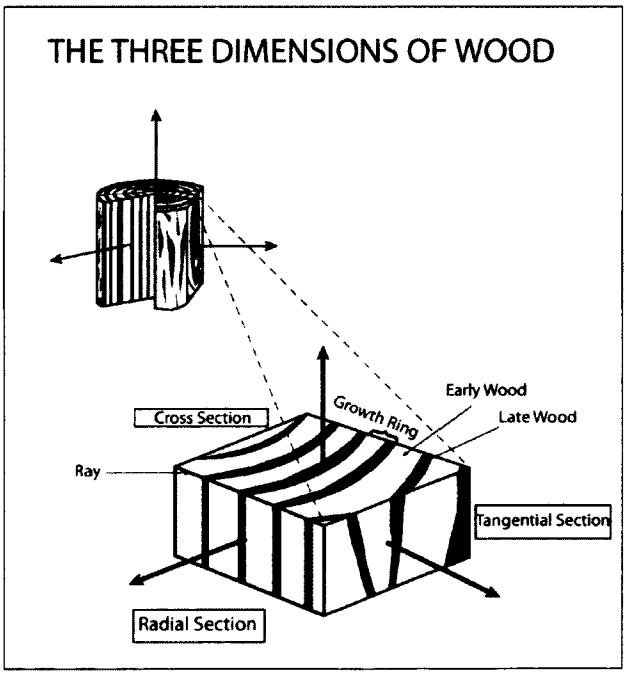


Figure 3.9: The three planes of wood used in charcoal identification (Used with permission from Alix 2001).

The first step in charcoal identification is determining whether a fragment comes from an angiosperm (such as *Salix, Betula, Populus, Alnus* or *Empetrum nigrum*) or a gymnosperm (such as *Picea* or *Larix*) tree or shrub species (Panshin and de Zeeuw 1980: 174). The cross-section is especially useful in determining whether a specimen is an angiosperm or gymnosperm. The presence of vessels indicates a specimen is an angiosperm species, and the absence of vessels indicates that it is a gymnosperm species. If it was impossible to make this distinction using the cross-section, examining the tangential section for these vessels was the next step (Alden 1995, 1997; Arno 1988; Greguss 1972; Ilic 1987, 1990; Schweingruber 1978, 1990).

Figure 3.10 shows the three different planes of a typical angiosperm and gymnospem. Figure 3.11 shows a spruce (*Picea*) specimen identified for this thesis – a gymnosperm, while Figure 3.12 shows a cross section of an uncharred (photographed as an example) crowberry (*Empetrum nigrum*) specimen – an angiosperm. Note that the crowberry specimen has a large number of round, differently sized vessels between each growth ring while the spruce specimen does not. This difference is also noticeable in Figure 3.10 where angiosperms and gymnosperms are compared side by side.

Figure 3.10: Angiosperm (right) and Gymnosperm (left) structures (From Hoffmeyer 1995).

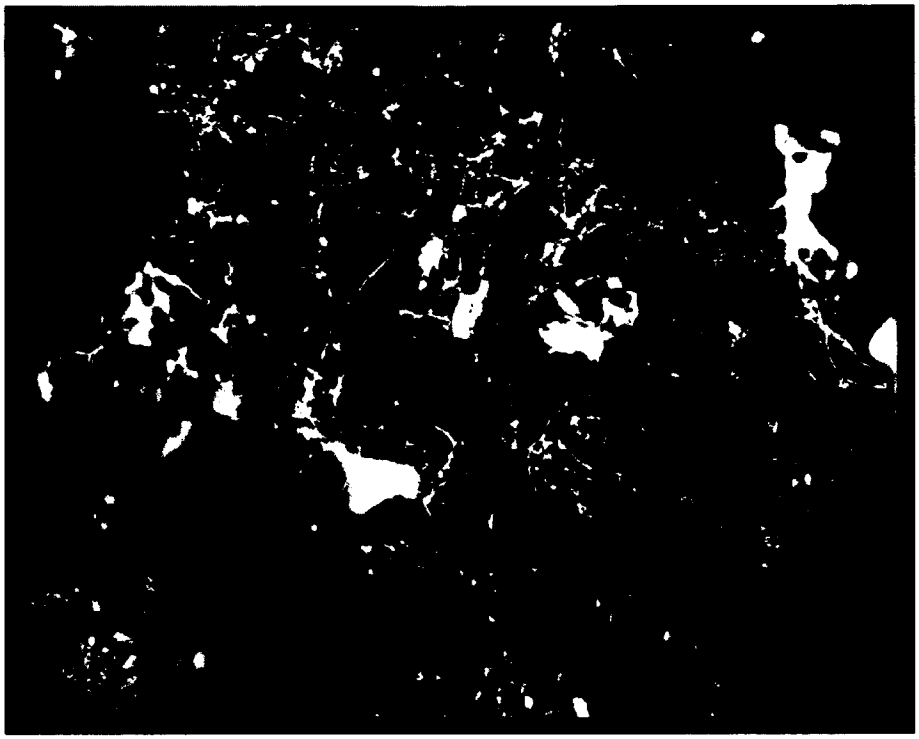


Figure 3.11: Spruce (*Picea*) Cross section (x50).

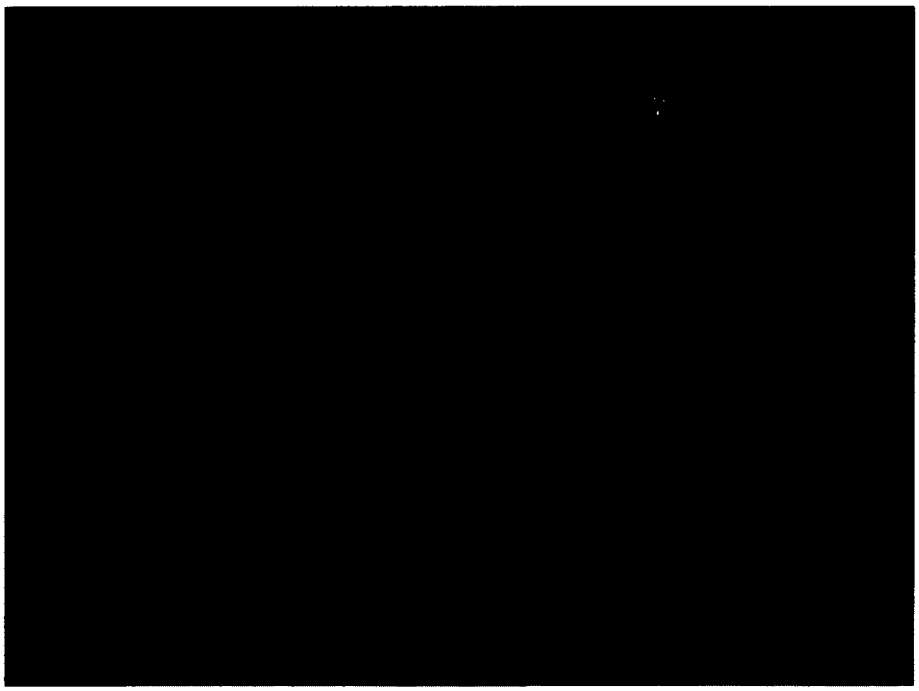


Figure 3.12: Cross section of *Empetrum nigrum* (crowberry) twig (x50). Note: This uncharred specimen is only an example - all specimens identified were charred.

Once it is clear that the specimen is either an angiosperm or a gymnosperm, more specific identification becomes possible. In most cases, charcoal was identified to at least the genus level. Identifications were made using comparative material collected from the boreal forest and kept at the Alaska Quaternary Center. The identification process was also aided with reference manuals and atlases such as Panshin and de Zeeuw's (1980), Hoadley's (1990), Benkova and Schweingruber's (2004), and Schweingruber's (1990).

Several genera are difficult to distinguish from one another. In cases where it was possible to differentiate between similar woody taxa, their unique characteristics were noticeable enough to make a firm distinction. For spruce and larch, although their cross sections are essentially identical, there are subtle differences in the radial section. The only distinguishing characteristic between these two genera is the type of pit seen on the wall of the ray tracheids, which unfortunately, is often destroyed through combustion (Bartholin 1979; Anagnost et. al. 1994). Therefore, charcoal fragments could only be identified as *Picea/Larix* cf. *Picea* or *Picea/Larix* cf. *Larix* in this study, and not firmly to one genera or another.

Distinguishing between *Salix* and *Populus* is similarly difficult. The best way to distinguish between these types of wood is to examine the tangential and radial sections. While *Salix's* ray tracheids are, for the most part, obviously heterocellular in the tangential and radial sections, the ray tracheids in *Populus* are very homocellular with only a few square and upright cells (Benkova and Schweingruber 2004: 374-378). The difficulty lies in determining whether a specimen is

heterocellular enough to be willow, or homocellular enough to be poplar. In cases where identification cannot be established with certitude, a specimen is labeled as poplar/willow (*Populus/Salix*).

Some other charcoal specimens could not be identified because they were very small, or very vitrified. Only one of these unidentified specimens appears to be a twig. The vast majority of these undetermined specimens probably cannot be identified due to extensive damage, virtrification, or because of the saturation of a fat-like residue. A few samples, however, may be identifiable with additional study.

Statistical Analyses

Standardization

For statistical analyses, the macrofossil data were standardized and tested for normality. Since the macrofossil data comes from samples of various sizes, the first step was to standardize all counts to what they would be if the sample size were 150 ml – about the size of the smallest samples analyzed. To standardize the data, the total macrofossil count was divided by the original sample size in ml, and then multiplied by 150.

After standardizing macrofossil volume to 150 ml, the data were tested for normality. Since it failed to attain a normal distribution, the data were transformed by taking the square root. Transforming the data in this way reduces the range of the maximum and minimum values so that the scatter is not as great. The square root function yielded more normally distributed macrofossil data, and so all macrofossil counts at 150 ml were transformed by taking the square root. After

completing this step, the macrofossil data were more suitable for parametric statistical analyses.

Organization

The macrofossils recovered from the analyzed samples include leaves, stems, seeds, bracts, seed holders, buds and bud scales. What part of a plant is preserved in an archaeological context is important to consider for both taphonomic and spatial behavioral studies. For the statistical tests carried out in this thesis, plant parts from the same taxon were all grouped as a single variable. For instance, preserved *Empetrum nigrum* remains are usually leaves or seeds, but instead of having separate categories for *Empetrum nigrum* leaves and *Empetrum nigrum* seeds, all *Empetrum nigrum* plant parts were grouped into the same variable category of "*Empetrum nigrum.*" In cases where a taxon consisted only of one plant part, the qualifier remains attached to the taxon variable – i.e. "*Betula* bract."

For statistical testing, macrofossil remains that could only rarely be identified to the species level, the variable combines multiple species into the larger genus category. For instance the category "*Vaccinium*" includes *Vaccinium vitis-idaea, Vaccinium uliginosum* and undifferentiated *Vaccinium* sp. macrofossil remains.

The standardization and transformation of data was only necessary for the macrofossil counts. Although the charcoal samples also came from the same samples, the data were already more or less normally distributed because charcoal

count was relatively uniform. By identifying roughly 50 pieces of charcoal from most samples – regardless of sample size or how many charcoal fragments were collected from that particular sample – the charcoal data were already regularized enough to be suitable for further parametric statistical analyses. Some samples, however, contained very small numbers of charcoal specimens, and so in some cases, the charcoal count is lower than 50 fragments.

Testing

Although descriptive data such as counts, percentages, means, pie charts, bar charts and the like can help point to patterns that may exist in a dataset, using statistical tests can confirm whether or not these perceived patterns actually exist in a statistically significant sense. The human brain can detect patterns that do not truly exist in a statistical sense – in other words, humans may perceive patterns in random data. Statistical tests help eliminate this subjectivity. The statistical tests used are relatively simple and robust; for both charcoal and macrofossils one-way analysis of variance (ANOVA) tests were used.

A one-way ANOVA is the simplest type of ANOVA test (Weiss 2008: 802). It compares the means of two or more samples, and tests against the assumption (the null hypothesis) that the samples are the same. By observing the F distribution - the estimates of population variance within and between the samples - conclusions can be made about whether the samples are the same, or not. Large values for F show

that the means between different samples vary more than would be expected assuming that the samples are the same.

In this thesis, statistical significance exists (i.e., you can reject the null hypothesis) when the alpha level (the probability of committing a Type I error – rejecting the null when it should be accepted) is equal to or less than 0.05. With this alpha level, there is a 95% confidence level. Near statistical significance exists when the alpha level is equal to or less than 0.1, meaning there is a 90% confidence level. When you can reject the null hypothesis, it means that there is a statistically significant difference between the samples (Norusis 2010: 312-316). When differences are found, a Tukey's post-hoc test can help identify what specific elements within the samples are making them different from one another. A Tukey test is only necessary when there are two or more categories to compare.

One-way ANOVA tests help to highlight differences between house features, and within house features for charcoal and macrofossil remains. For macrofossil remains, fill samples and off-site samples can be compared and contrasted against one another using ANOVA. Fill and off-site samples can also be compared against cultural samples to see if the macrofossil profile of cultural samples is different from the profile of non-cultural samples.

For statistical analyses, samples were grouped in several different ways. All samples taken from test-pits are considered "Off-Site" samples, and all samples taken from above cultural levels on-site are considered "Fill" samples. Note that "Off-Site" and "Fill" samples were only analyzed for macrofossils.

It is necessary to mention the rationale for grouping off-site samples from different ridges, and fill samples from all three houses excavated in 2010. Firstly, in order to make a statistical test meaningful, there must be a sufficient number of samples. The number of samples analyzed for this thesis are already small, and separating the off-site samples further by ridge would make statistical analyses much more difficult. The ridges at Cape Espenberg are of varying height and do have slightly different vegetation communities. These differences, however, are not great enough to be statistically significant between ridges, or test-pit depths when analyzed with an ANOVA test.

Fill samples from all three houses excavated in 2010 (Feature 68a, 33 and 21) were included together in one category. This again is partially due to the requirements of statistical tests. Also, it is assumed the samples are similar enough to be comparable; all fill samples come from the collapsed remains of an ancient wood and sod house located on near, but separate, ridges. Again, no statistically significant differences exist between fill samples from different levels or different house features. By grouping "Off-Site" and "Fill" samples together, it is possible to compare samples from clearly cultural contexts to those from clearly non-cultural samples.

Sample Abundance, Fatty Residues and Local Woody Vegetation

Another way in which to discern meaningful differences between different samples is to measure macrofossil abundance. After standardizing the samples to

150 ml, it is possible to compare the macrofossil and charcoal counts, or the abundance of the samples. By knowing how many individual macrofossils were recovered from a certain sample, context, or feature it is possible to come to conclusions regarding the samples. For one, a measure of abundance can compare the presumably natural abundance of macrofossils in non-cultural samples to the presumably anthropogenically influenced abundance of plants in cultural samples. It is also important to pay attention to the genera recovered in a sample to make meaningful conclusions.

For charcoal, tests were also conducted on the presence and absence of what is presumed to be fatty residue and on growth curvature. Lab tests run in the Applied Science, Engineering and Technology Laboratory (ASET) at the University of Alaska, Anchorage by Benjamin Applegate have shown the presence of small quantities of lipids in several selected samples. Due to the small sample size, however, these results are inconclusive. In knowing how the modern and historic Inupiat used animal fats in their fires, it seems likely that a larger sample size would show the presence of lipids conclusively (Saario and Kessel 1966: 972). Assuming that the residue on the charcoal is in fact lipid material, observing the abundance of fatty residues on charcoal fragments can suggest how often fats were introduced to wood and charcoal, whether it may have been added intentionally as fuel or unintentionally through other means.

By observing the ratio of local growth (twigs) to non-local growth (driftwood) in each house feature, it is possible to determine how much woody fuel

came from either source. Remarking the presence or absence of bark and pith can help determine whether small diameter specimens are twigs, and hence originate from local vegetation. This distinction is important since some small diameter fragments, such as roots, can survive the driftwood deposition process.

Fegel (1941: 19) notes that wood rays are more numerous in branches than in trunks and roots, both in conifers and hardwoods, which is another way to identify trunk, root and branch specimens. Paradis-Grenouillet et. al. (2010: 202) have determined that the radius of a charcoal fragment can be determined by measuring the angle and distance between two rays. Although possible, this was not done for this thesis. Instead, charcoal was separated into three categories - charcoal with unknown growth curvature, charcoal fragments that are not from twigs (probably driftwood), and twigs (probably local vegetation).

Charcoal fragments with unknown growth curvature either lack a single complete annual growth ring, or have a warped, indeterminate growth curvature. It is unclear whether fragments with unknown growth curvatures come from driftwood or local vegetation. Charcoal fragments that are not twigs are those fragments with strong, moderate or weak curvatures that lack intact bark and pith. These charcoal fragments most likely originate from driftwood.

Specimens in the "Twigs" category have a small diameter, are largely intact and maintain both their bark and pith. Undoubtedly, the vast majority of charcoal specimens in the "Twigs" category come from local plants. It is only the specimens in the "Twigs" category that are certainly local growth. Although not impossible, it is

highly unlikely that small twigs or branches survive the driftwood cycle with their bark intact. See Figure 3.12 for an example of a carbonized twig found in a sample. Note the remaining bark adhering to the upper side of the specimen, as well as the tight growth curvature.

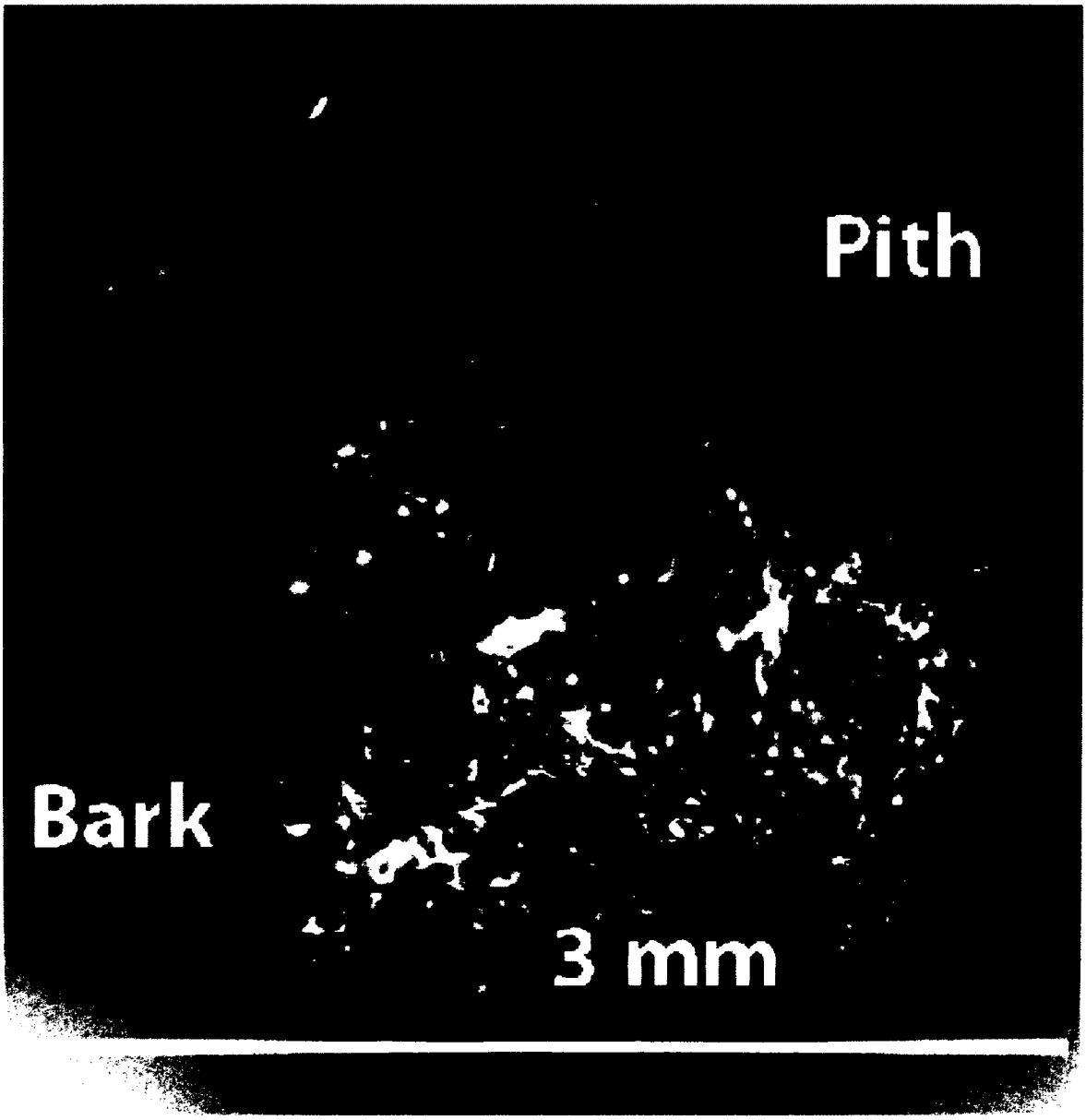


Figure 3.13: Carbonized Twig at 50x magnification.

Chapter 4: Results

As outlined in the method's section, the following section presents both statistical results, as well as observations from various charts and graphs. Using this combination of methods ensures that valid statistical patterns are uncovered, but also allows more detailed data to emerge. This chapter begins by comparing macrofossil taxa abundance between different categories of samples: fill samples, off-site samples and cultural samples. Statistical analyses are then performed on these samples. Within the cultural samples, the different contexts identified in the house features – the tunnel, living area and burnt area – are also compared and contrasted against one another statistically and with descriptive data. Charcoal data is presented similarly later in the chapter using largely the same methods, but without the fill and off-site samples for comparison. Note that all output from statistical tests has been placed in the Appendix section.

Macrofossil Results

Sample Abundance

One way in which to discern differences between different types of samples is to measure their abundance. For this thesis, the standardized sample size is 150 ml. By measuring how many macrofossils are found in each standardized 150 ml sample, it is possible to determine which samples have the greatest macrofossil abundance, and how the abundances of cultural, fill and off-site samples differ.

The descriptive data shown in Table 4.1 indicates that the Off-Site samples contain, on average, about 344 macrofossils per every 150 ml of sediment. Fill samples contain an average of 191 macrofossils, and Cultural samples contain 18 macrofossils per 150 ml of sediment.

Conducting an ANOVA test (Table A.1) shows that these differences are statistically significant. The Tukey Post-Hoc test in Table A.2 shows that there is a statistically significant difference only between the cultural samples and the off-site samples.

Table 4.1: Macrofossil Abundance per 150 ml.

Sample type	Mean	No. of Samples	Std. Deviation	Minimum	Maximum	Range
Cultural	18.4	37	26.3	.08	166.8	166.7
Fill	191.2	13	287	2	1042.2	1040.2
Off-Site	344.7	10	768.3	.21	2289	2288.7
Total	110.2	60	351.1	.08	2289	2288.9

Also note that although the cultural samples have the fewest macrofossils per 150 ml, they contain the greatest diversity of plant taxa. In fact there is an inverse relationship between macrofossil abundance and macrofossil taxa diversity. As seen in Table 4.2 the cultural samples, which only contain 18 macrofossil samples per 150 ml, have 26 taxa total. The fill samples have 15 macrofossil taxa, and the off-site samples, despite the sample abundance, are not very diverse. There were only 11 different macrofossil taxa identified in all of the off-site samples. This may suggest that cultural samples have low macrofossil abundance and high diversity due to anthropogenic factors, since plant vegetation off-site appears to be so much more

abundant, and dominted by relatively few taxa. Table 4.3 lists the taxa found in cultural contexts and their documented ethnographic uses.

Table 4.2: Macrofossil Taxa by Sample Type.

Cultural	**Fill**	**Off-Site**
Empetrum nigrum	*Empetrum nigrum*	*Empetrum nigrum*
Polygonum sp.	-	-
Vaccinium sp.	*Vaccinium* sp.	*Vaccinium* sp.
Arctostaphylos sp.	-	-
-	-	*Betula* sp.
-	*Ericaceae* sp.	-
Eriophorum sp.	-	-
-	*Equisetum* sp.	-
Hippuris sp.	*Hippuris* sp.	*Hippuris* sp.
Lathyrus maritimus	*Lathyrus maritimus*	-
Ledum sp.	-	-
Potentilla sp.	*Potentilla* sp.	*Potentilla* sp.
Ranunculus sp.	*Ranunculus* sp.	*Ranunculus* sp.
Rosaceae	-	-
Rubus chamaemorus	-	-
Rumex sp.	-	-
Salix sp.	*Salix* sp.	*Salix* sp.
-	-	*Salix/Potentilla*
-	*Salix/Vaccinium*	-
Artemisia sp.	-	-
Carex sp.	*Carex* sp.	*Carex* sp.
Gramminoid sp.	-	-
Poaceae sp.	*Poaceae* sp.	-
Andromeda polifolia	*Andromeda polifolia*	*Andromeda polifolia*
Apiaceae sp.	-	-
Asteraceae sp.	-	-
Caryophyllaceae sp.	-	-
Cerastium sp.	-	-
Montia sp.	-	-
Juncus sp.	-	-
-	*Myriophyllum spicatum*	-
-	-	*Polytrichum* sp.
-	*Potamogeton* sp.	-
Sparganium hyperboreum	-	-
26 total	**15 total**	**11 total**

Table 4.3: Macrofossil Species and Genera in Cultural Contexts (Oswalt 1957; Jones 2010; McIntosh 1999; Anderson 1939).

	Empetrum nigrum	Edible and medicinal
	Polygonum sp.	Edible and astringent
	Salix sp.	Salix pulchra edible, bark as pain reliever
	Arctostaphylos sp.	Edible berry
	Eriophorum sp.	Edible stem bases
	Hippuris sp.	Young plants are edible
	Lathyrus maritimus	Roasted, made into type of coffee
	Potentilla sp.	Made into tea
	Ranunculus sp.	Shoots edible after boiling off poison
	Rosaceae sp.	Edible - rosehips and cloudberries
	Rubus chamaemorus	Favored edible berry
	Rumex sp.	Edible greens
	Vaccinium sp.	Edible berries
	Artemisia sp.	Medicinal tea
	Ledum sp.	Medicinal tea
	Carex sp.	Yes - sedge mats
	Gramminoid sp.	Same uses as sedges and grasses
	Poaceae sp.	Mats, menstrual pads, insulation, bedding
	Andromeda sp.	None - poisonous
	Apiaceae sp.	None
	Asteraceae sp.	None
	Caryophyllaceae sp.	None
	Cerastium sp.	None
	Juncus sp.	None
	Montia sp.	None
	Sparganium hyperboreum	None

Statistical and Visual Analyses

Comparing Taxa abundance in Fill to Off-Site Samples

In moving onto statistical analyses, first it is necessary to compare the fill samples to the off-site samples to see what differences, if any, might exist in terms of taxa abundance, or if the two sample types are roughly identical. The ANOVA results (Table A.3) reveal that there are no statistically significant differences between the fill samples and off-site samples. The following graph (Figure 4.1) shows all of the off-site samples and fill samples analyzed for this study. Note that macrofossils are by far the most abundant in the 0-10 cm layer of the off-site samples, followed by buried paleosols. These samples from the dark, organic soil near the top of the profiles often contain many more macrofossil remains than samples taken from the lighter, sandier, lower levels. Any samples taken from lower than 10 cm contain very few macrofossil remains in comparisons. In the fill samples, there are also more macrofossils in the top levels than in the lower levels – especially in Feature 68a. The top levels of fill should be the levels least influenced by human occupation.

Although the differences between the fill and off-site samples are not great enough to be statistically significant, visual analysis provides more details about these samples. For instance, crowberry is by far the most abundant genus. Furthermore, birch is found only in the off-site samples, and not in any of the fill samples. Also, note the abundance of *Potentilla* seeds in the second Feature 68a fill sample. This probably represents a dropped *Potentilla* seed capsule.

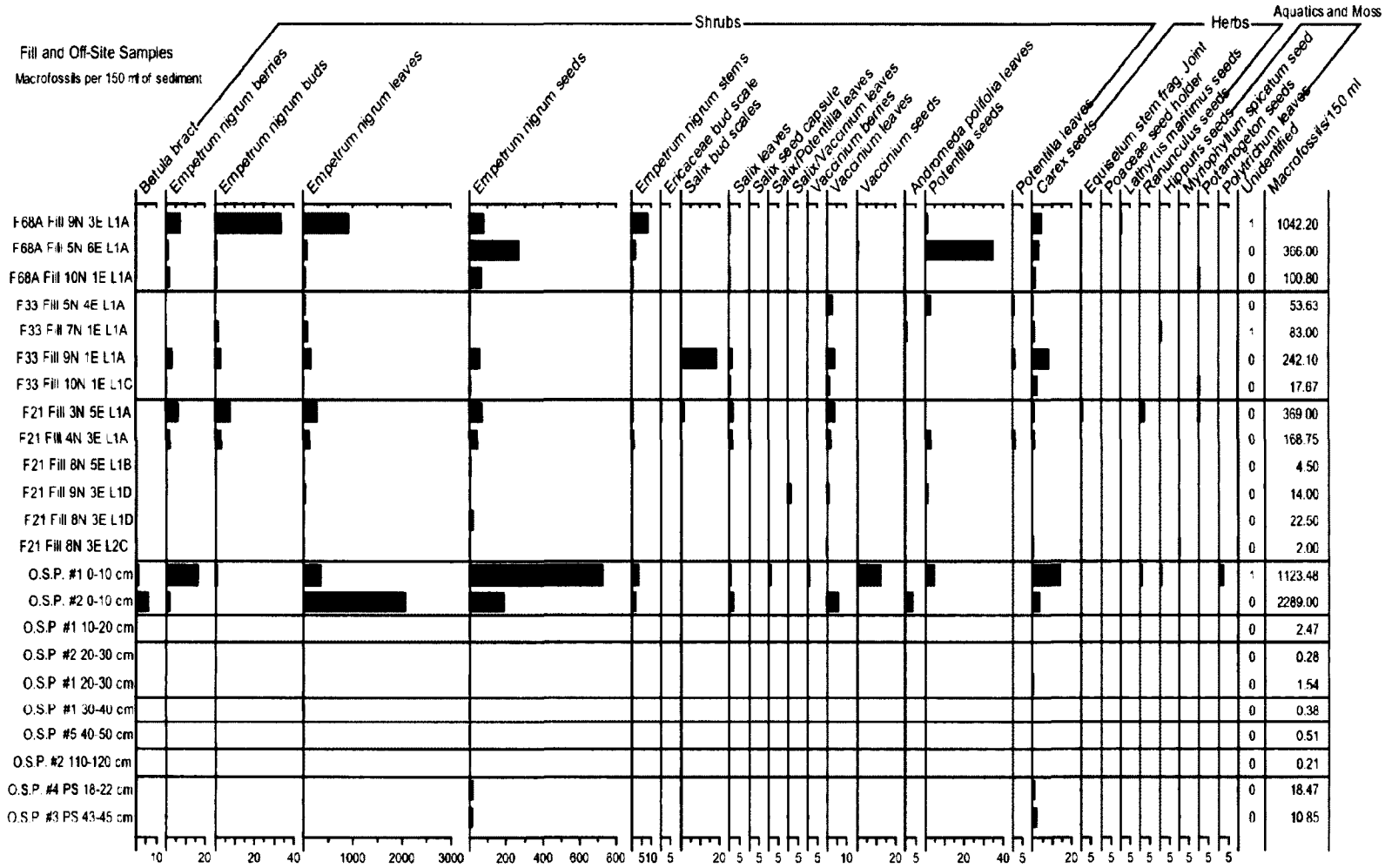


Figure 4.1: Off-Site and Fill Sample Comparison (O.S.P = Off-Site Pit).

Comparing all Cultural samples to Off-Site Samples

The next step is to compare all of the Off-Site samples to all of the 37 samples taken from cultural contexts. The ANOVA results (Table A.4) show that there is a statistically significant difference in the abundance of *Betula* and *Empetrum nigrum* macrofossils. The Off-Site samples contain significantly more remains of each taxa. In fact, there are no *Betula* remains in any cultural samples.

Figure 4.2 compares all of the Off-Site samples to all of the cultural samples. Note the high counts of *Empetrum nigrum* in the Off-Site samples when compared to the cultural samples. Also, observe that *Betula* counts are relatively low in the Off-Site samples. It is because the cultural samples have no *Betula* that this relationship is statistically significant. Why the cultural samples contain no *Betula* remains, even though various species of birch grow on the landscape, is unknown. It seems as if the inhabitants of Feature 33 and Feature 68a were avoiding this plant for some reason or another.

The Off-Site samples also contain noticeably more macrofossil remains per 150 ml than the cultural samples – at least, in the top 10 cm of sediment. The statistically significant differences for crowberry and birch, and the radically different macrofossil richness between upper off-site samples and cultural samples strengthens the notion that off-site samples do indeed represent the natural vegetation growing on the landscape, while the macrofossils found in cultural samples presumably represent anthropogenic introduction.

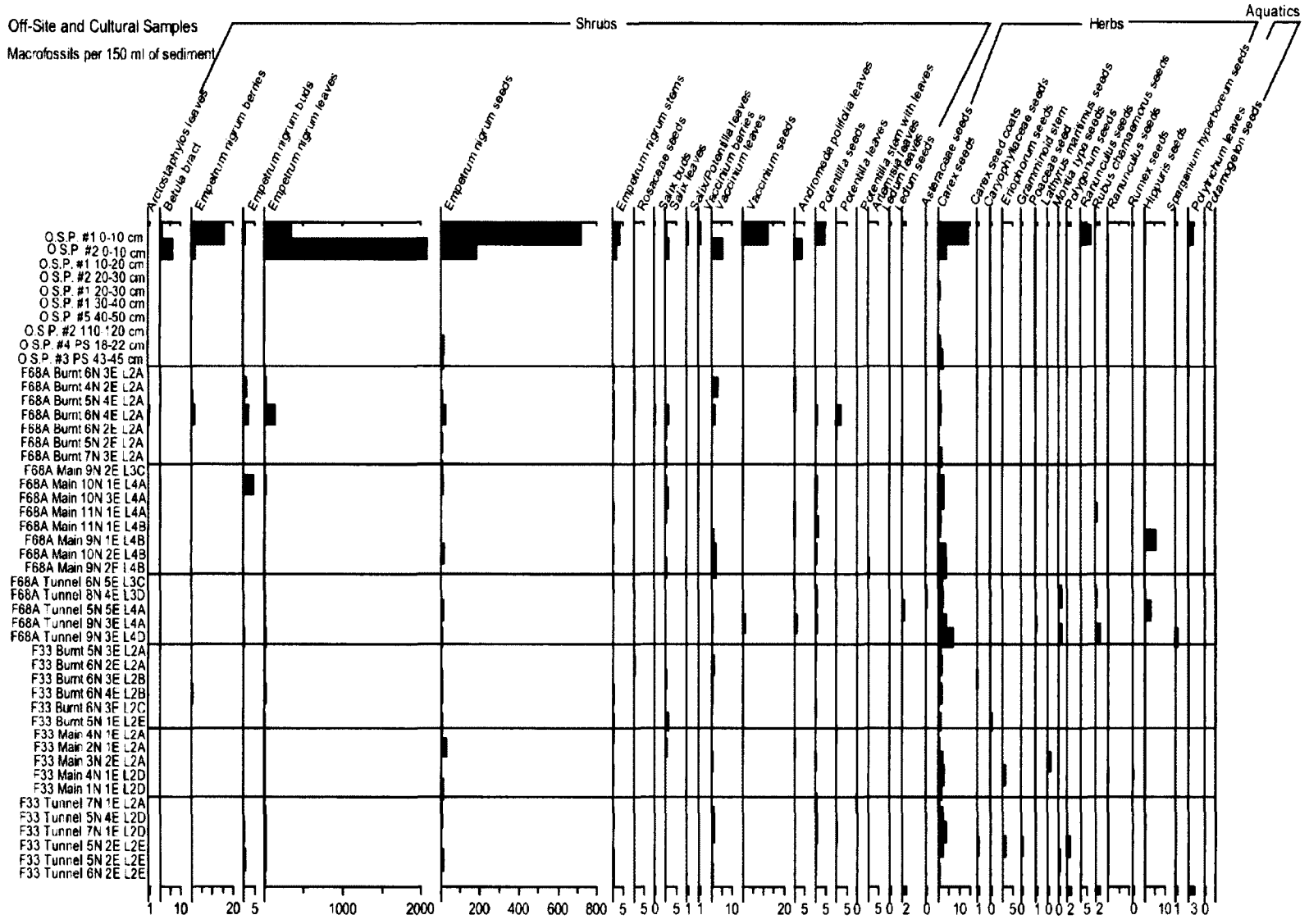


Figure 4.2: Comparing Off-Site to Cultural Macrofossil Taxa.

Comparing all Cultural samples to Fill Samples

Off-Site samples, or more accurately off-house samples, come from contexts assumed to be unaffected by anthropogenic activity, and Fill samples come from contexts that, presumably, have been indirectly influenced by anthropogenic activity. The fill samples are thought to represent what sort of vegetation was growing, and being blown in and blown out of the depression created by the collapsed house feature below. The ANOVA results (Table A.5) show that there are no statistically significant differences between the cultural samples and the fill samples in terms of taxa abundance.

Figure 4.3 compares the fill samples to the cultural samples. Note the abundance of *Empetrum nigrum* in the fill samples; the differing amounts of Empetrum nigrum in the fill samples compared to the amounts of Empetrum nigrum in the cultural samples is not statistically significant at the 0.05 alpha level. Again, notice the large number of *Potentilla* seeds in the fill of Feature 68a. As mentioned earlier, this probably represents the presence of a dropped *Potentilla* seed capsule. Furthermore, the upper fill samples have strikingly more macrofossil remains per 150 ml than the cultural samples. While the cultural samples average about 19 macrofossils per 150 ml, the level 1 fill samples average out to about 207 macrofossils per 150 ml.

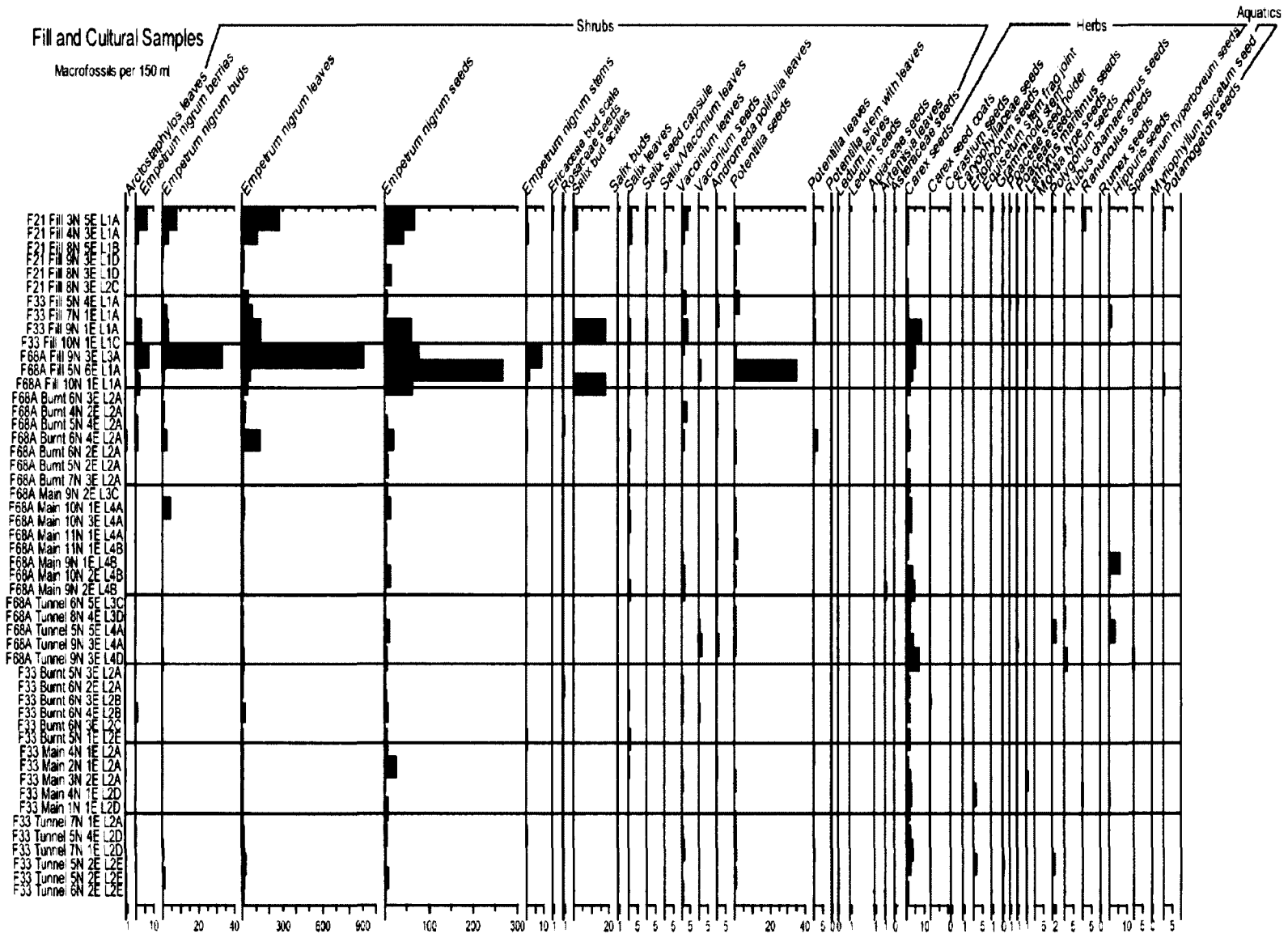


Figure 4.3: Fill and Cultural Sample Macrofossil Comparison

Comparing Contexts within each house Feature: Feature 33

Looking at how contexts vary within houses can provide more specific data about each house feature. The ANOVA test in Table A.6 shows that for Feature 33, the abundance of *Potentilla* is different in a statistically significant sense between contexts. The Tukey Post-Hoc Test (Table A.7) indicates that there is more *Potentilla* in the tunnel of Feature 33 than in Feature 33-1, the burnt area.

In the Nome area, a certain species of *Potentilla*, *Potentilla fruticosa*, was known ethnographically to have been made into tea (Anderson 1939: 715). Although this particular *Potentilla* species does not grow at Cape Espenberg, it is possible that the inhabitants of Feature 33 were doing something similar with a different species of *Potentilla*. Looking at Figure 4.4, at first glance it appears that the cultural samples contain more *Empetrum nigrum* (crowberry) seeds than leaves. Note that the scales in Figure 4.4 for these two plant parts are very different.

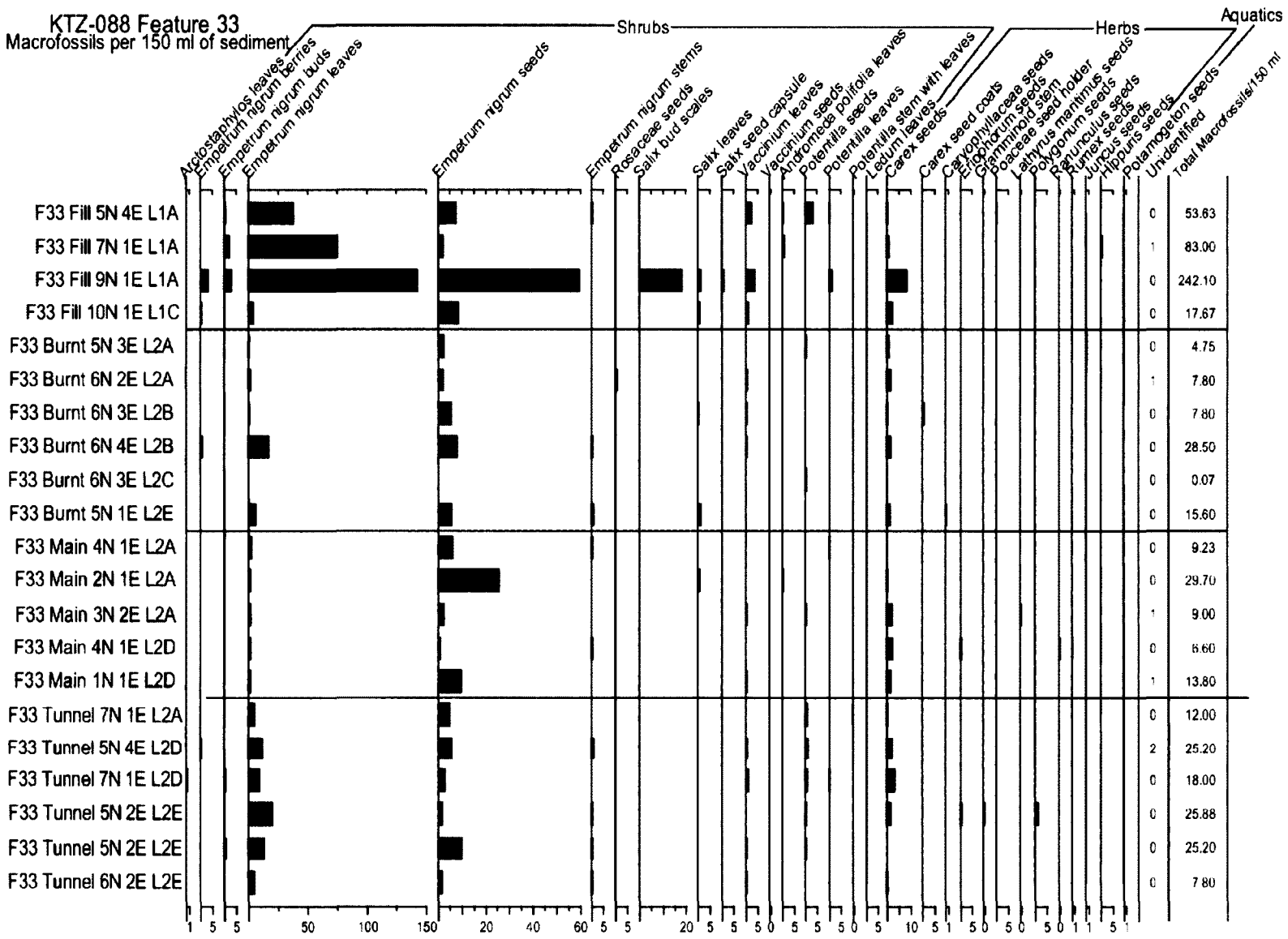


Figure 4.4: Feature 33 Macrofossil Comparison by Context (note x-axis scales vary).

Comparing Contexts within each house Feature: Feature 68a

An ANOVA test shows that, between the contexts in Feature 68a, there is a statistically significant difference in the quantities of *Carex* and *Ledum* (Table A.8). The Tukey Post-Hoc Text (Table A.9) shows that *Carex* is statistically more abundant in the tunnel of Feature 68a than in Feature 68a-1, the burnt area. There is also a near-significant relationship for *Carex* between the burnt area and the living area. *Carex* is significantly more abundant in the tunnel of Feature 68a, and nearly significantly more abundant in the living area.

Ledum is only found in the tunnel area of Feature 68a, and not in the other two contexts. For this reason, the relationship shown in the Tukey Post-Hoc test (Table A.9) is near significant between the tunnel and the burnt area, and the tunnel and the living area. There is simply no *Ledum* in either one of these contexts, which drives the near statistical significance.

In Figure 4.5, it is easy to see the abundance of *Carex* in the tunnel of Feature 68a compared to the living area and the burnt area, but it is also easy to see that the burnt area of Feature 68a has little *Carex* when compared to either context. Furthermore, note the presence of edible *Hippuris* in the tunnel and living areas of Feature 68a, and its absence in the burnt area of this house feature. Both statistical and visual analyses suggest that the burnt area of Feature 68a is very different from the other contexts within this house feature.

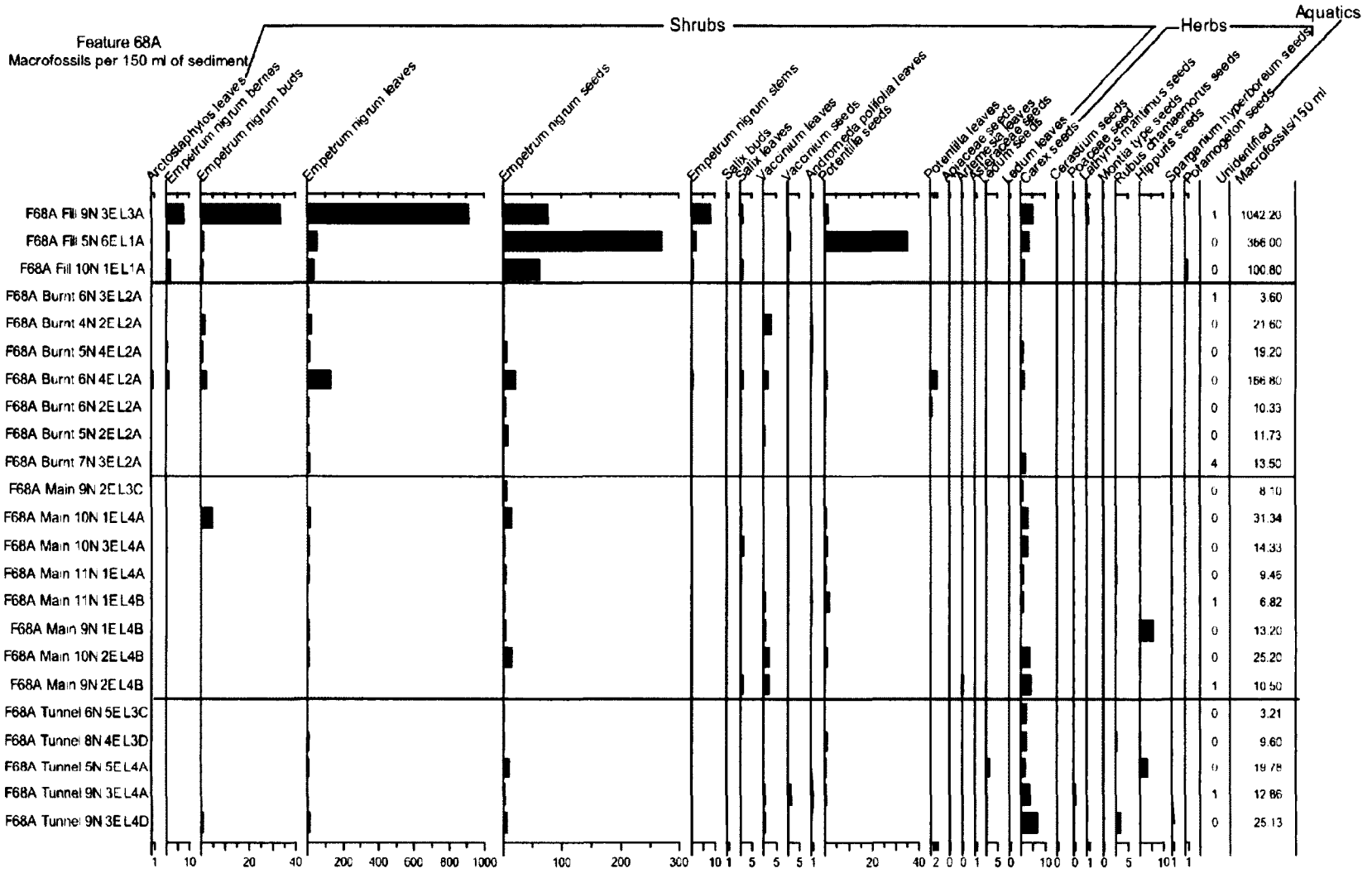


Figure 4.5: Feature 68a Macrofossil Taxa Comparison by Context (note x-axis scales vary).

Comparing Contexts to Contexts Statistically and Visually

F-33-1 compared to F-68a-1

Comparing the macrofossil remains from the burnt features of both houses with an ANOVA test (Table A.10) reveals that there are no statistically significant differences, nor any near statistically significant differences. At least for uncharred, non-woody remains F-68a-1 and F-33-1 are statistically indistinguishable. Looking at Figure 4.6, however, it is possible to see that even though the samples are statistically indistinguishable, there are indeed differences.

For one, the burnt area of Feature 68a, in general, contains more macrofossil remains per 150 ml than the burnt area of Feature 33. Most noticeable is the greater abundance of *Empetrum nigrum* in Feature 68a when compared to Feature 33. Feature 68a's burnt area also contains more edible *Potentilla* leaves and seeds. The burnt area of Feature 33, however, contains more *Carex* than the burnt area of Feature 68a.

These differences, although not statistically significant, could provide insight into how the areas around each burnt area were used. The uncharred plants could have been introduced by human activity, and may even be related to the use and function of the burnt areas themselves. Note, however, that the burnt areas of both house features contain very few herbaceous taxa when compared and contrasted to the other contexts. This may be an artifact taxonomy if herbs were being burned. Alternatively, perhaps the inhabitants were introducing primarily woody taxa.

Below in Figure 4.6 note that Feature 68a's 6N 4E Level 2A sample looks quite different from the rest of the macrofossil samples taken from the burnt area of this house feature. It is possible that this sample looks different from the other samples because of where it was taken from inside the house. The macrofossils in this particular sample may come from the limits of two different cultural features – the tunnel and the burnt area.

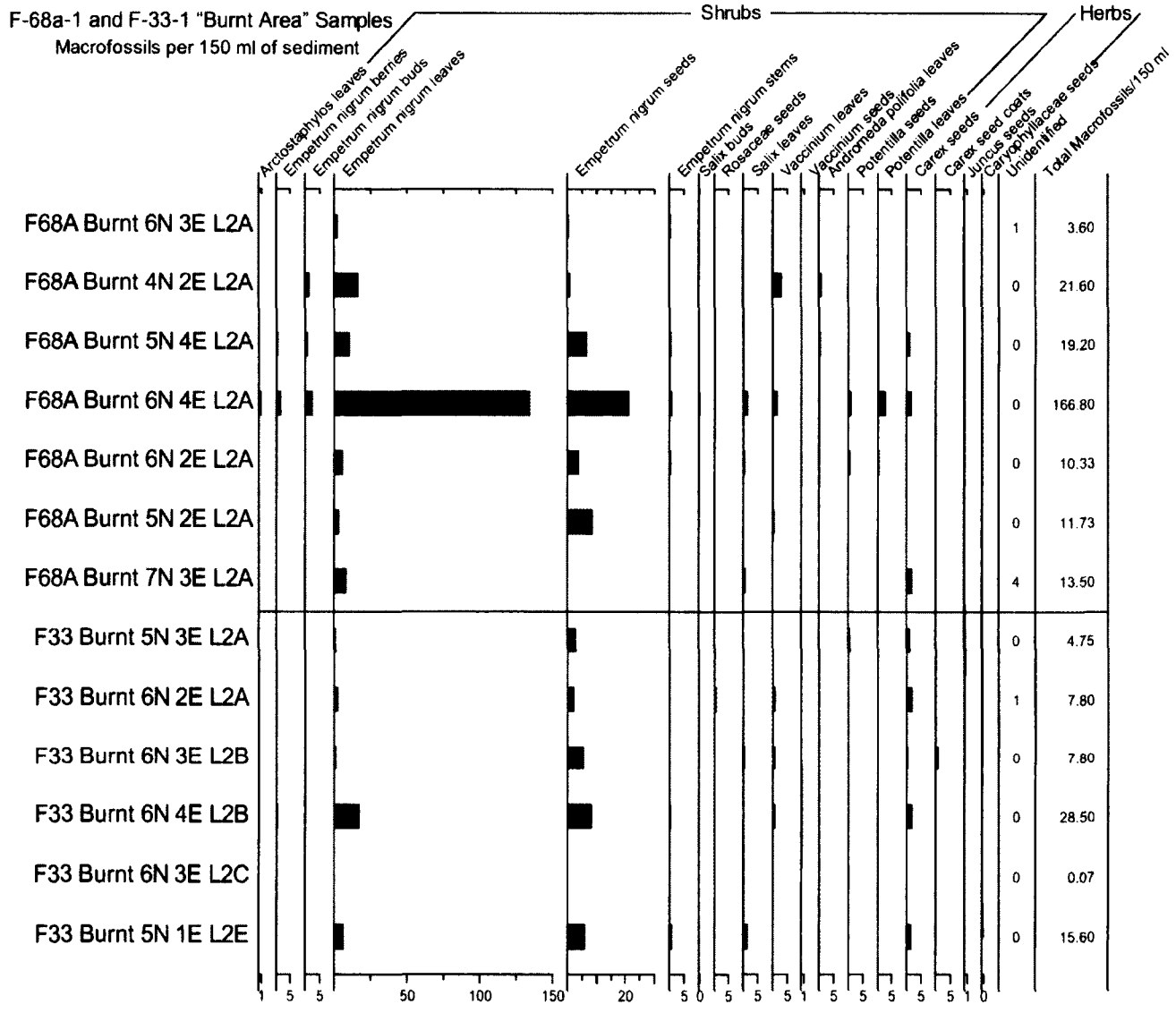


Figure 4.6: F-68a-1 and F-33-1 Macrofossil Comparison

Feature 33 Living area compared to Feature 68a Living area

An ANOVA test reveals that there are no statistically significant differences between the living areas of Feature 68a and Feature 33 (Table A.11). There are not even any relationships that are near significant between the living areas of these two houses. As seen in Figure 4.7 Feature 68a, however, does have more *Vaccinium*, *Potentilla*, *Rubus chamaemorus*, and especially, *Hippuris* than Feature 33. Whether this is an issue of taphonomy, or whether this represents differential uses of the living areas of each house feature is unknown. Since all three of these taxa have documented historic cultural uses, cultural differences in time may explain the greater abundance of these taxa in Feature 68a. Alternatively, perhaps the differences between house features are an artifact of seasonality.

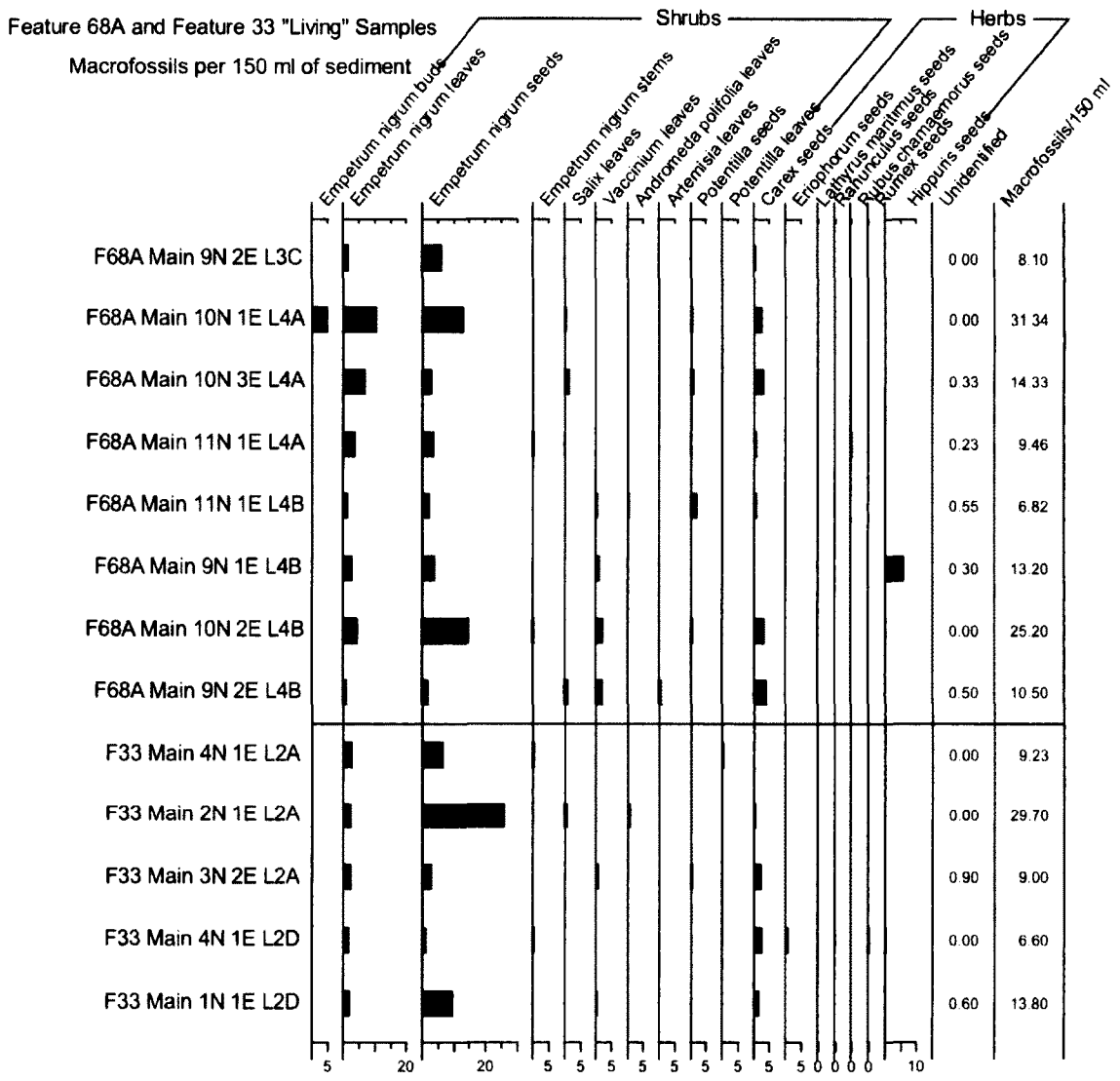
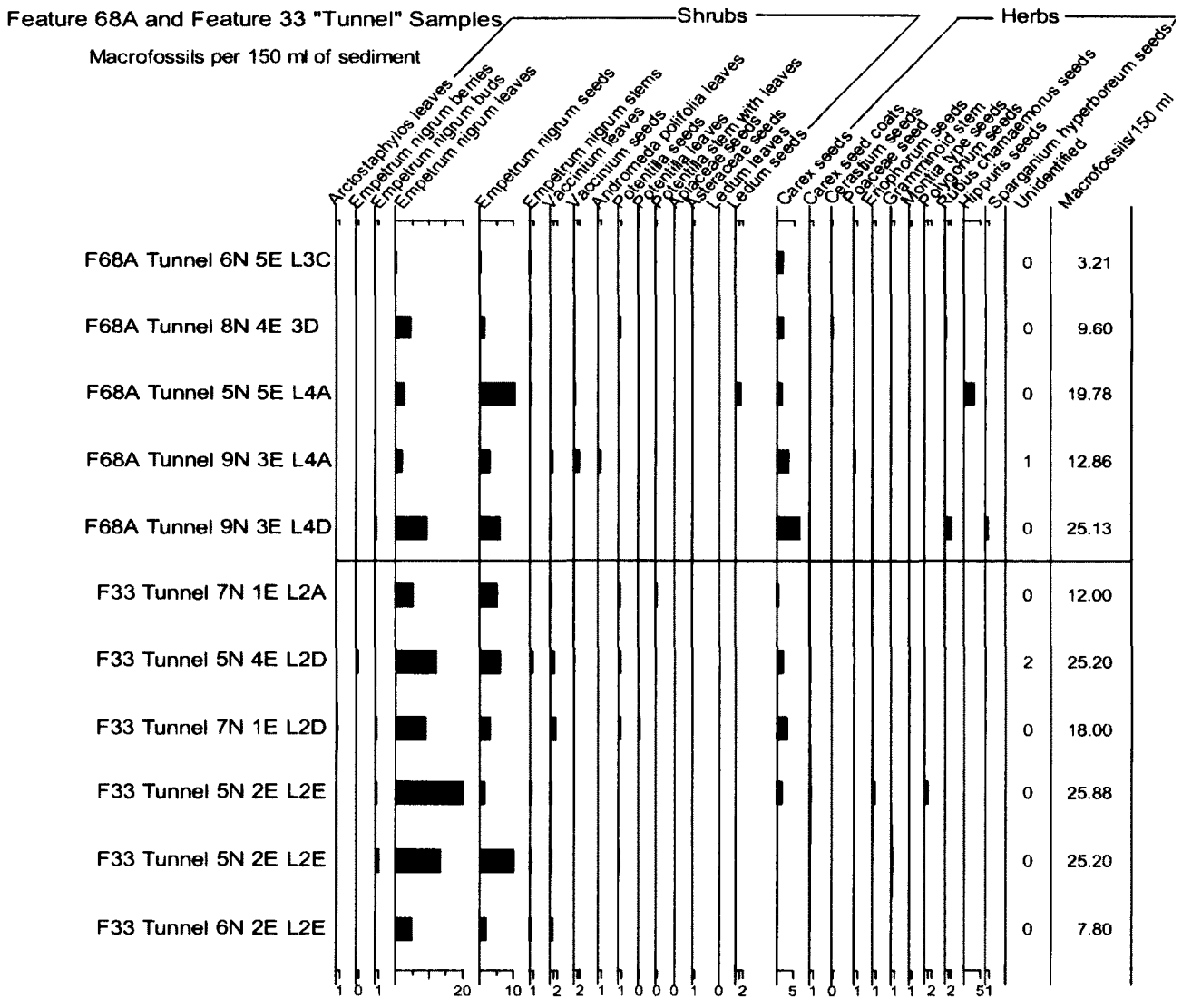


Figure 4.7: Macrofossil taxa in the living areas of each house feature.

Feature 33's Tunnel compared to Feature 68a's Tunnel

An ANOVA test (Table A.12) shows that the tunnel of Feature 33 is statistically significantly different from the tunnel of Feature 68a when it comes to the abundance of *Empetrum nigrum*. At the .08 level, this relationship is near significant. Also, the abundance of *Carex* is near statistically significant.

In looking at Figure 4.8, it is clear that these statistical relationships are driven by the abundance of *Empetrum nigrum* in Feature 33's tunnel, and the relative abundance of *Carex* in Feature 68a's tunnel. Beyond these statistically significant relationships, the figure below shows that Feature 68a's tunnel has more edible *Hippuris* and *Rubus chamaemorus* seeds than the tunnel of Feature 33. Also, note that Feature 68a contains *Ledum* whereas Feature 33 has no *Ledum* remains. The tunnel of Feature 68a is the only context in either house that contains *Ledum*.


Feature 68A and Feature 33 "Tunnel" Samples
Macrofossils per 150 ml of sediment
Shrubs
Herbs
Arctostaphylos leaves
Empetrum nigrum berries
Empetrum nigrum buds
Empetrum nigrum leaves
Empetrum nigrum seeds
Empetrum nigrum stems
Vaccinium leaves
Vaccinium seeds
Andromeda polifolia leaves
Potentilla seeds
Potentilla leaves
Potentilla stem with leaves
Asteraceae seeds
Ledum leaves
Ledum seeds
Carex seeds
Carex seed coats
Carastium seed
Poaceae seed
Eriophorum seeds
Grammnoid seeds
Monitia type seeds
Polygonum seeds
Rubus chamaemorus seeds
Hippuris seeds
Sparganium hyperboreum seeds
Unidentified
Macrofossils/150 ml
F68A Tunnel 6N 5E L3C
F68A Tunnel 8N 4E 3D
F68A Tunnel 5N 5E L4A
F68A Tunnel 9N 3E L4A
F68A Tunnel 9N 3E L4D
F33 Tunnel 7N 1E L2A
F33 Tunnel 5N 4E L2D
F33 Tunnel 7N 1E L2D
F33 Tunnel 5N 2E L2E
F33 Tunnel 5N 2E L2E
F33 Tunnel 6N 2E L2E
0 0 0 1 0 0 0

Charcoal Results

Charcoal Sample Richness

Although not all of the charcoal fragments recovered from cultural samples were identified, every fragment was counted in order to measure sample abundance. As seen in Table 4.4, Feature 68a has an average of about 103 charcoal fragments per 150 ml of sediment, and Feature 33 has an average of about 85 charcoal fragments per 150 ml. This difference between house features is not great enough to be statistically significant (Table A.13) and could be a result of having fewer samples from Feature 33. Still, the maximum abundance of charcoal in Feature 68a is about 1074 per 150 ml, while the maximum abundance in Feature 33 is only about half of that at about 589 charcoal fragments per 150 ml. So the data may still suggest that Feature 68a does, in reality, have greater charcoal abundance than Feature 33 even though the relationship is not statistically significant.

Table 4.4: Charcoal Richness per 150 ml by Site.

Site	Mean	No. of Samples	Std. Deviation	Minimum	Maximum	Range
68a	103	20	243	5	1074	1068
33	85	16	144	8	589	581
Total	95	36	202	5	1074	1068

When charcoal richness was measured by context, the results, seen in Table 4.5, largely met what was expected. The burnt areas of both houses contain statistically significantly more charcoal than the living areas, and near statistically significantly more charcoal than the tunnel (Tables A.14 and A.15) The burnt areas of both houses contain an average of about 211 fragments per 150 ml, while the living area contains about 27 fragments, and the tunnels contain about 33 fragments.

Table 4.5: Charcoal Richness per 150 ml by Context.

Context	Mean	No. of Samples	Std. Deviation	Minimum	Maximum	Range
Burnt Area	211	13	308	21	1074	1052
Living	27	13	28	5	111	106
Tunnel	33	10	34	7	94	87
Total	95	36	202	5	1074	1068

When the richness of the different contexts were compared and contrasted against one another (burnt feature in Feature 68a to burnt feature in Feature 33, living area in Feature 68a to living area in Feature 33 and tunnel in Feature 68a to tunnel Feature 33), the only near statistically significant difference that exists is between the tunnels of Feature 68a and Feature 33. A Tukey Post-Hoc test in Table A.15 demonstrates this. Looking at Table 4.6, the mean charcoal richness of each context is quite different. The tunnel of Feature 68a averages about 14 charcoal fragments per 150 ml while the tunnel of Feature 33 averages about 51 charcoal

fragments per 150 ml. What this may suggest is that the burnt area of Feature 33 is associated with the occupation of the house feature, whereas the burnt area of Feature 68a is not associated. The inhabitants of Feature 33 may have been inadvertently carrying in more charcoal fragments because of the use of the potentially associated burnt area.

The burnt area of Feature 33 has an average of 168 charcoal fragments per 150 ml while the burnt area of Feature 68a has an average of 248 charcoal fragments per 150 ml. Since the burnt area of Feature 68a contains more charcoal than the burnt area of Feature 33, but has less charcoal in its tunnel than Feature 33, the fact that there is a greater abundance of charcoal in the tunnel of Feature 33 than in the tunnel of Feature 68a could also have something to do with the potential association of Feature 33's burnt area with the occupation of the house feature.

Table 4.6: Charcoal Richness per 150 ml in the tunnels of Feature 68a and Feature 33.

Site	Mean	No. of Samples	Std. Deviation	Minimum	Maximum	Range
68a	14	5	7	7	24	17
33	51	5	41	8	94	86
Total	33	10	34	7	94	87

Angiosperm and Gymnosperm Charcoal Abundance

For several tests, the charcoal specimens identified were grouped into two categories – Angiosperm and Gymnosperm. The taxa in the Angiosperm category are *Alnus, Betula, Empetraceae, Empetrum nigrum, Salix, Salix/Populus, Populus* and

undifferentiated angiosperm fragments. The taxa in the Gymnosperm category are *Picea/Larix* cf. *Picea, Picea/Larix* cf. *Larix* and undifferentiated gymnosperm fragments. Comparing the ratio of angiosperms to gymnosperms by feature and context can suggest fuelwood selection practices.

An ANOVA test (Table A.16) indicates that there are significantly more Angiosperm fragments in Feature 33 than in Feature 68a. When pooled and compared by context, ANOVA and Tukey-Post Hoc test results (Tables A.17 and A.18) show that there are more Angiosperm charcoal fragments in the burnt features of both houses than in the living areas.

Figure 4.9 is a visual representation of angiosperm and gymnosperm abundance by feature and context. Note that F-33-1, the burnt area of Feature 33, contains a relatively large amount of angiosperms when compared to any other context in either feature. In every context, however, gymnosperms make up more than half of the charcoal fragments identified. ANOVA tests show that there are no statistically significant differences between contexts within each feature – the tunnel in Feature 68a is not significantly different than the living area or burnt feature, for instance (Tables A.19 and A.20). Between features, however, there are statistically significant differences. The tunnels and living areas of Feature 68a and Feature 33 are not statistically different, but F-33-1 has significantly more angiosperm specimens than F-68a-1 (Tables A.21, A.22 and A.23).

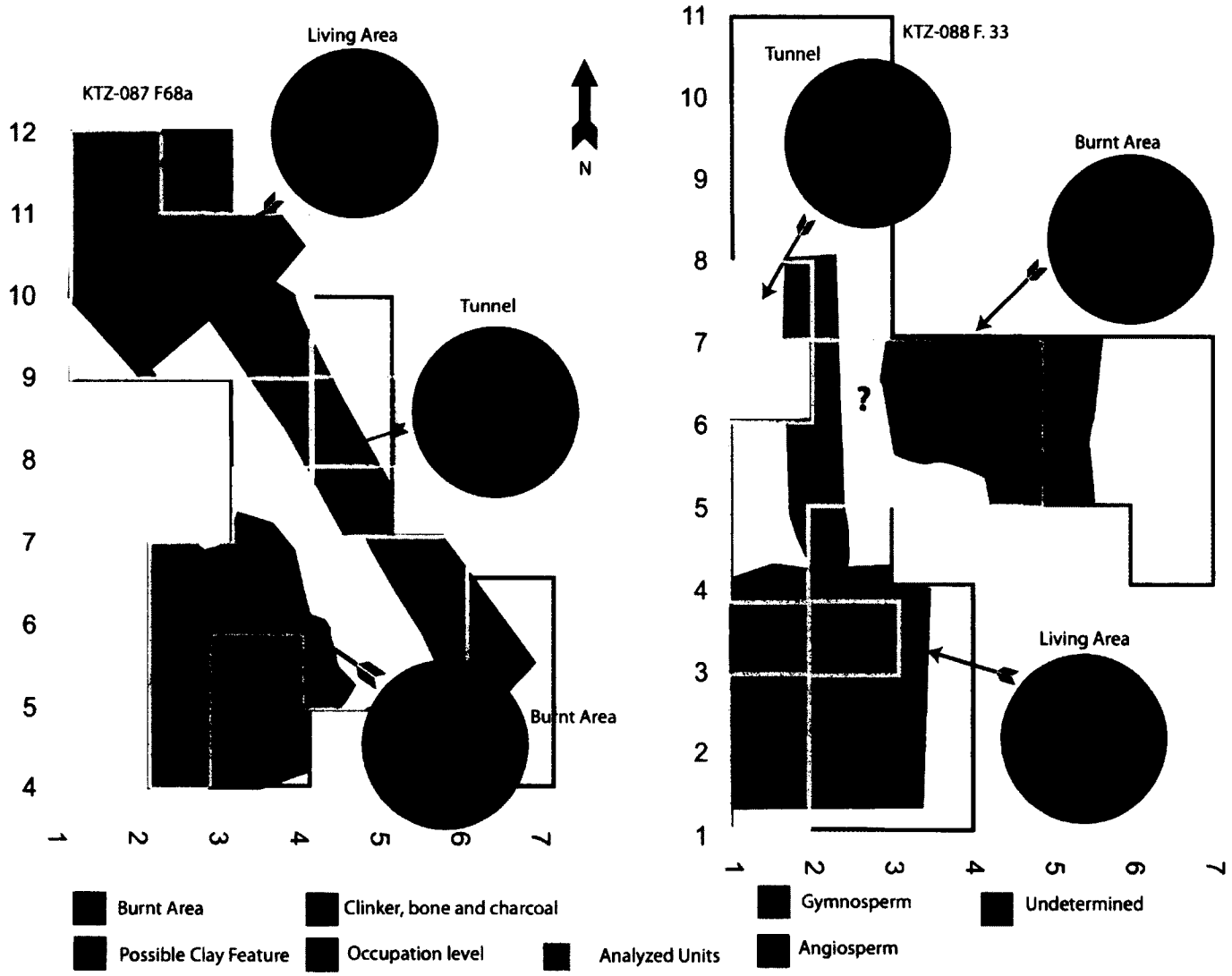


Figure 4.9: Angiosperm and Gymnosperm Charcoal Fragments by Context and Feature.

Charcoal Taxa Analysis by Feature and Context

The most abundant charcoal taxon is *Picea*, which constitutes nearly 61% of the total sample. *Salix* is a distant second, comprising only 14% of all the charcoal fragments. Next are undifferentiated angiosperms at 8% and undifferentiated gymnosperms at 5%. Table 4.7 gives a count of charcoal fragments for each taxon, and its percentage of the total. To understand the data more fully, however, tests need to be conducted concerning differences between features and contexts.

Table 4.7: Charcoal Taxon Counts and Percents.

ID	Sum	Percent
Alnus sp.	2	0.1%
Angiosperm, undifferentiated	132	8.2%
Betula sp.	14	0.9%
Ericaceae sp.	11	0.7%
Rosa/rubus nigrum	2	0.1%
Gymnosperm, undifferentiated	83	5.1%
Picea/Larix cf. *Picea* sp.	981	60.7%
Picea/Larix cf. *Larix*	40	2.5%
Populus sp.	29	1.8%
Populus/Salix	40	2.5%
Salix sp.	230	14.2%
Undetermined	53	3.3%
Sum	1617	100%

Feature 68a Context Comparison

An ANOVA test (Table A.24) shows that there are no statistically significant differences between the contexts in Feature 68a – the burnt feature, living area and

tunnel. There are also no relationships that approach statistical significance. In looking at Figure 4.10, however, variability between samples can be seen – especially in the differing abundance of angiosperm and gymnosperm charcoal fragments. Two samples from unit 9N 3E come from different levels, and yet both contain almost exclusively gymnosperms, and both have relatively low charcoal counts. From looking at this figure, it appears that charcoal occurred in living area contexts in smaller amounts, which further suggests that fires were not indeed being lit inside of the house. Also, notice that Feature 68a has very little birch charcoal. Remember that neither house had any uncharred birch remains.

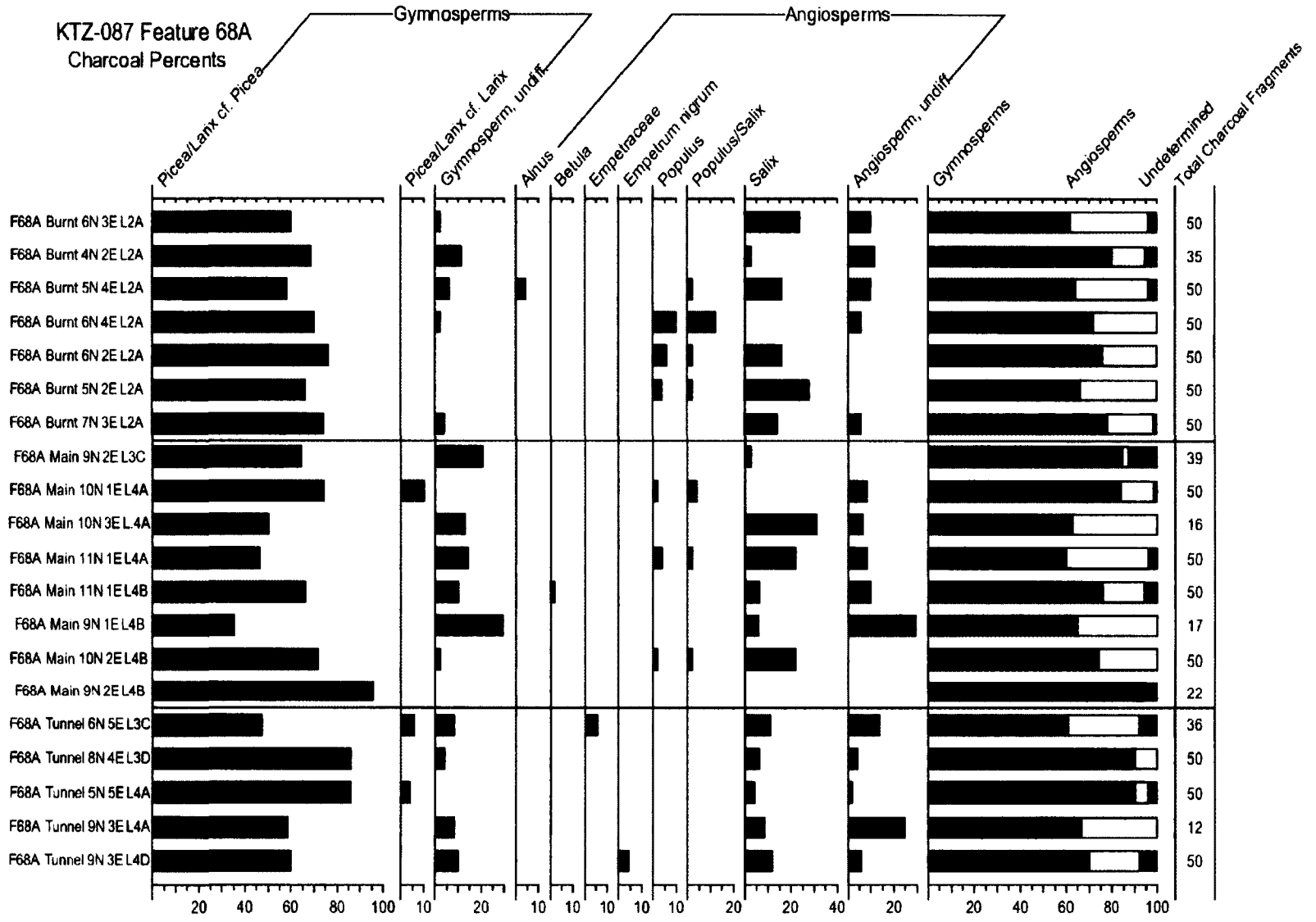


Figure 4.10: Macrofossil Taxa in the tunnels of each house feature.

Feature 33 Context Comparison

An ANOVA test (Table A.25) compares the contexts within Feature 33 against one another in the same way they were compared for Feature 68a. The charcoal taxa percentages from the burnt area, living area and tunnel were all compared statistically. As in Feature 68a, there are no statistically significant differences by context, and no relationships that approach statistical significance.

In observing Figure 4.11, some patterns that are not statistically significant are visible. For one, notice that the burnt area of Feature 33 contains a visibly greater ratio of angiosperms to gymnosperms than any other context within the house. Also, the burnt area of Feature 33 contains more undifferentiated angiosperm specimens than any other context – this is probably due to the relatively greater abundance of fatty residues in the burnt area of Feature 33 as will be discussed later.

Furthermore, like Feature 68a, Feature 33 also contains low amounts of birch charcoal. Both the relative lack of birch charcoal, and the total lack of birch macrofossils, suggests something about the importance of birch for the inhabitants of Features 68a and 33.

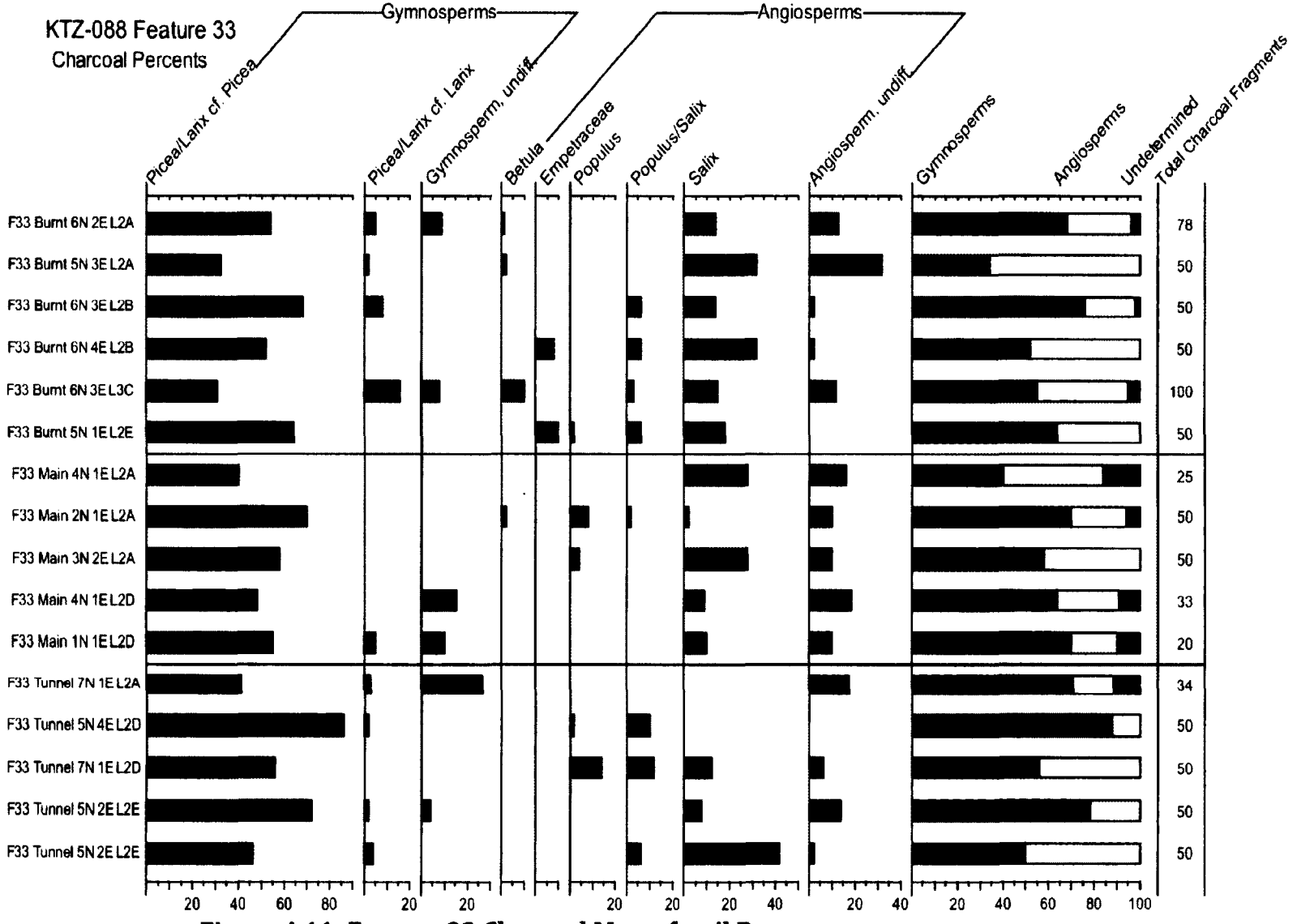


Figure 4.11: Feature 33 Charcoal Macrofossil Percentages.

Comparing Charcoal in F-68a-1 and F-33-1

Comparing contexts between houses statistically for charcoal, like macrofossils, can reveal differences and similarities. When the burnt areas of both houses were compared, no statistically significant differences were found. There are two relationships, however, that approach statistical significance. Looking at Figure 4.12 it is not difficult to see that the burnt area of Feature 68a contains more *Picea/Larix* c.f. *Picea* than Feature 33. This relationship is reflected by the ANOVA test in Table A.26 with this taxon approaching statistical significance. Also, observe the greater quantities of Angiosperm charcoal in the burnt area of Feature 33 – especially *Salix*. This relationship approaches statistical significance, with Feature 33 containing more *Salix* than Feature 68a.

Figure 4.12 reveals an ongoing trend in both house features – the relative lack of birch and poplar. Neither house contains significant amounts of either carbonized taxa even though both birch and poplar are found with some frequency in driftwood assemblages at Cape Espenberg. Poplar was even used in the construction of Feature 33 (Hoffecker and Mason 2011: 33). Poplar, however, seems to have been infrequently used to make fires. Finally, notice the small amounts of *Empetraceae* charcoal in the burnt area of Feature 33, and the lack of this taxon in Feature 68a. This relationship is not statistically significant, and nor does it approach statistical significance. In Feature 68a, however, there are more uncharred *Empetrum* macrofossils than in Feature 33. It appears then that the inhabitants of

both house features were eating *Empetrum* berries, but not burning much of the woody part of the plant.

It should also be noted that a large bulk sample about four liters in size was taken from the burned area, F-33-1. Both the heavy and light fraction in this sample was collected and analyzed. Using a raw count, the number of charcoal pieces and calcined or burnt bone fragments are very similar. A total of 622 pieces of charcoal were recovered from this sample, as were 544 burnt bone fragments. The charcoal and bone in this hearth is very fragmentary, but the bone fragments were considerably smaller than the charcoal fragments. The largest charcoal specimen was 4.5cm long, and only six other charcoal pieces were larger than 2cm in size. The rest were smaller than 1cm in length. A similar bulk sample was not taken from F-68a-1 because the burnt area was not as readily recognizable, or as sizable.

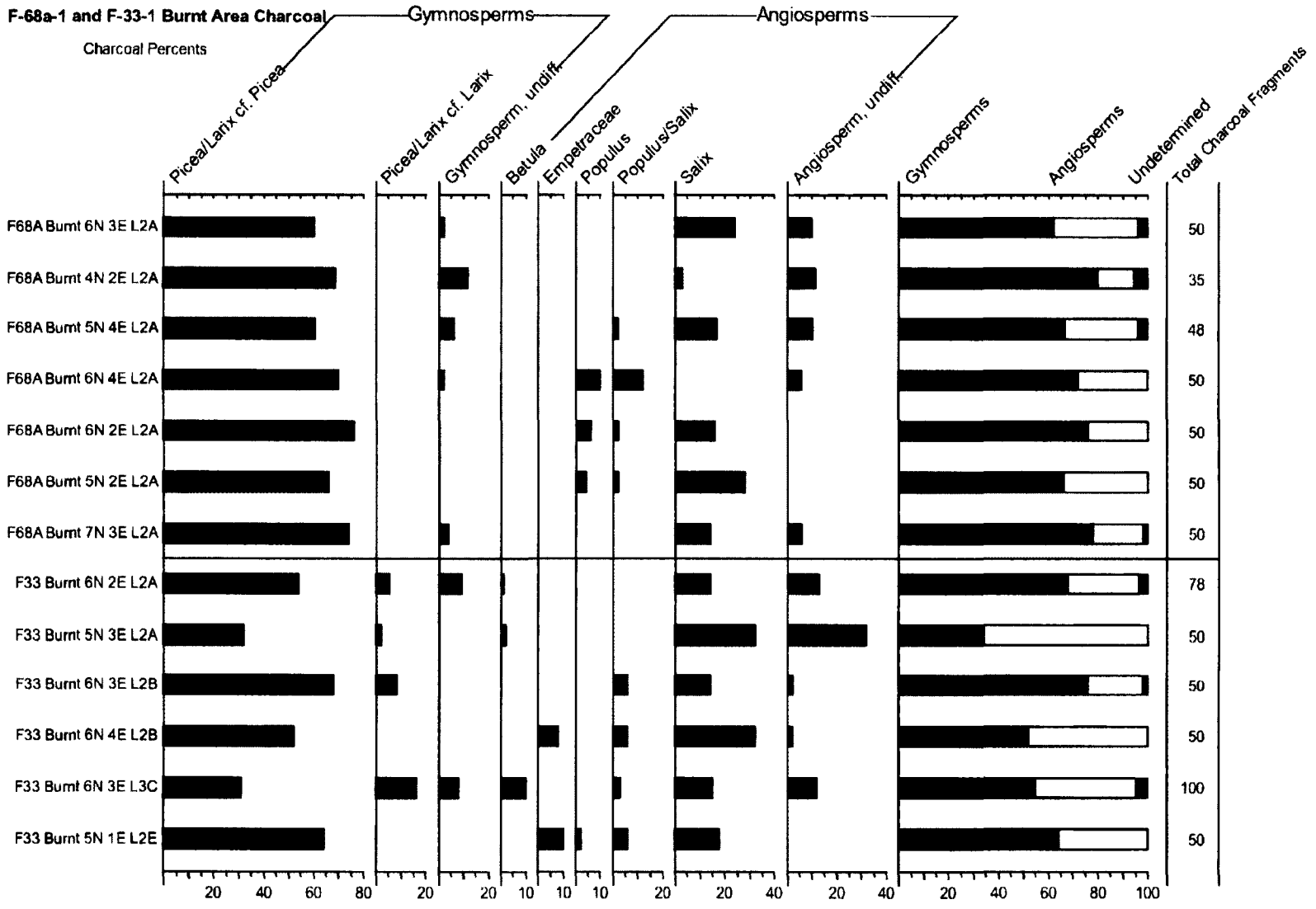


Figure 4.12: F-68a-1 and F-33-1 Charcoal.

Charcoal in the Living areas of each house feature

Statistically speaking, as indicated by the ANOVA test results in Table A.27, there are no differences between the charcoal composition of the living areas of Feature 68a and Feature 33. There are also no relationships that approach statistical significance. Looking at Figure 4.13, however, differences can be seen. Note again that Feature 33 has more angiosperm charcoal than Feature 68a. With the addition of more samples, it is possible that statistical significance could exist.

Also, remember that the living area of Feature 33 contained a ceramic lamp. As noted during excavation, the inhabitants of Feature 33 probably received the majority of light and warmth within their house from an oil lamp, and were not burning fires in the house. Although an oil lamp was not found in the living area of Feature 68a, it appears that not fires were being lit inside this house feature either. The charcoal found in the living areas of both house features was most likely inadvertently introduced.

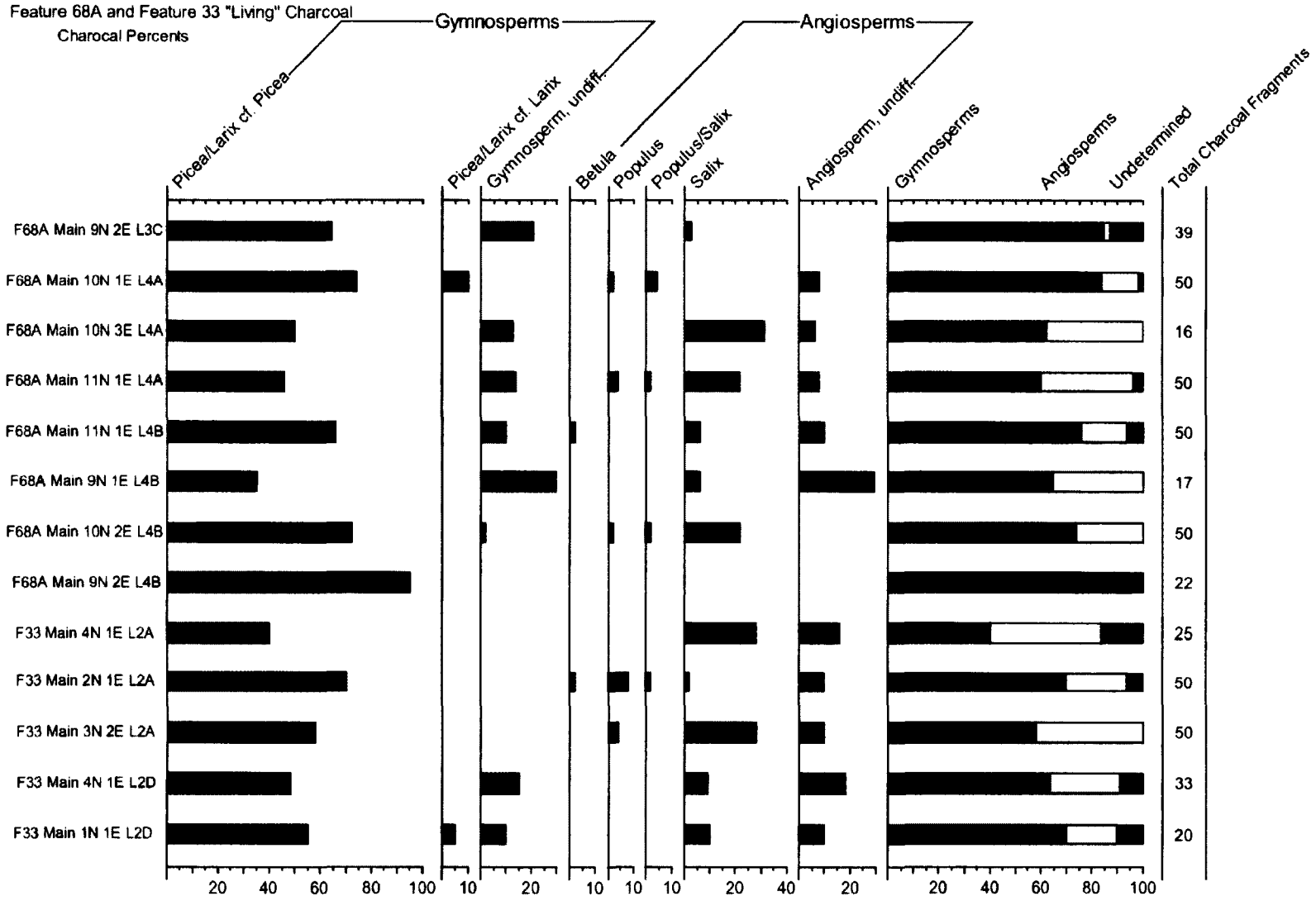


Figure 4.13: Living Area Charcoal.

Charcoal in the tunnels of each house feature

An ANOVA test in Table A.28 compares charcoal taxa abundance in the tunnels of both house features, and reveals that there are no statistically significant differences. There is a near statistically significant relationship, however, for *Populus/Salix*. Looking at Figure 4.14, this makes sense. Feature 68a contains no *Populus/Salix* charcoal. Feature 68a also lacks *Populus,* although this difference is not great enough to be statistically significant, or to approach statistical significance. This is consistent with Feature 33 having more angiosperm specimens than Feature 68a in every context, as can also be seen in Figure 4.14 when comparing the percentages of gymnosperms to angiosperms in the tunnel of each house feature. Finally, note the small amounts of *Empetraceae* and crowberry charcoal in the tunnel of Feature 68a. These taxa are lacking in the tunnel of Feature 33. Again, remember that although there are low amounts of *Empetraceae* charoal fragments, there are abundant *Empetrum* macrofossil remains.

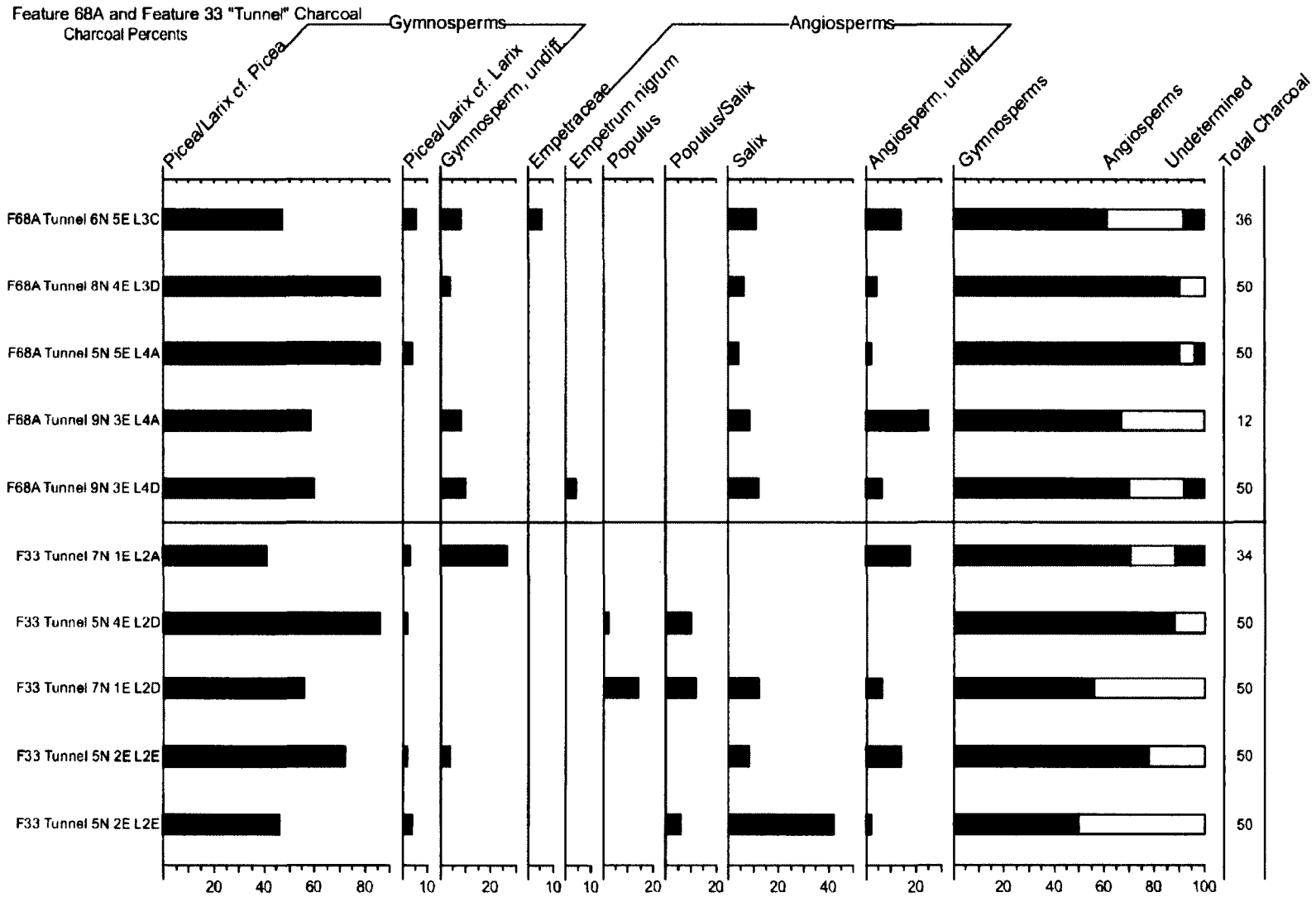


Figure 4.14: Tunnel Charcoal in each house feature.

Fatty Residue Presence by Feature and Context

As stated previously, laboratory tests detected only very small quantities of lipids on the charcoal specimens analyzed – so small, in fact, that the results are considered inconclusive. Knowing that, ethnographically, the Inupiat in the surrounding areas would often supplement their fires with blubber, we can assume with some certainty that the substance obsevered in many of the charcoal specimens is indeed fat (Saario and Kessel 1966: 972).

With the assumption that the substance saturating or coating much of the charcoal is likely fat, the following tests address the presence of fatty residue on charcoal specimens, and what its presence implies. There are varying degrees of fatty residue abundance or saturation on charcoal fragments. Some fragments have no fatty residue at all while others are full of fatty residue such as in Figure 4.15. Quantifying the degree of fatty residue saturation proved to be too subjective, and so the following analyses look only at the presence or absence of fatty residue.

Figure 4.15: Fat-like substance soaked into a charcoal fragment at 50x magnification.

As seen in Table A.29, there are no statistically significant differences between Feature 68a and Feature 33 in terms of fatty residue presence. When observing contextual differences however, there is a statistically significant relationship (Table A.30) A Tukey Post-Hoc Test (Table A.31) shows that the burnt areas in both features have, statistically speaking, significantly more charcoal fragments with some sort of fatty residue present than the living areas.

Comparing Contexts within Features

Within Feature 68a and Feature 33, there are no statistically significant differences by context for fatty residue presence (Tables A.32 and A.33). With Feature 68a, however, there is a relationship that approaches statistical significance (Table A.32). The burnt area of Feature 68a contains more charcoal with fatty residue present than any other context within that house feature. Table 4.8 shows that the average number of charcoal fragments with fatty residue present is about

39, while the living area has 24, and the tunnel has 26 charcoal fragments with fatty residue present on average.

Table 4.8: Average number of charcoal fragments in Feature 68a with Fatty Residue Presence by Context.

Context	Mean	No. of Samples	Std. Deviation	Minimum	Maximum	Range
Burnt Area	38.57	7	10.17	22	49	27
Living	24	8	14.1	5	44	39
Tunnel	26	5	13.87	2	37	35
Total	29.6	20	13.88	2	49	47

Comparing Contexts Between Features

Tables A.34, A.35 and A.36 show that there are no statistically significant differences for fatty residue presence when each context is compared. The burnt features, living areas and tunnels of both houses contain statistically similar quantities of charcoal fragments with fatty residue present. The levels of fatty residue presence are very similar between each house in fact.

Charcoal Fragment Growth Curve Comparison by Feature and Context

Feature 68a Growth Curvature Comparison by Context

The final analyses for this thesis examine differences between features and contexts in terms of growth curvature, namely the ratio between charcoal fragments that come from twigs, and charcoal fragments that do not come from twigs. Twigs are likely from locally growing shrubby vegetation, and not driftwood accumulations. The presence of bark, tight growth ring curvature and small

diameter are the three main characteristics that identify that charcoal originates from local vegetation instead of driftwood. Determining the ratio of twigs to non-twigs can help determine how heavily the inhabitants of Feature 68a and 33 were relying on local wood and driftwood.

In order to determine this, first, the contexts in Feature 68a were compared against one another statistically. An ANOVA test (Table A.37) shows that there are no statistically significant differences between contexts within this house, and that there are no relationships that approach statistically significance. The ratio of twigs to non-twigs in each context is statistically the same.

Looking at Figure 4.16, it appears that Feature 68a has very few twigs at all. The vast majority of charcoal in this house feature appears to have originated from driftwood, and not local wood. Even in the burnt area, where it would be expected that local vegetation might have been used for kindling, there are just a small number of twigs. There are even more twigs in the tunnel than in the burnt area. The living area contains hardly any twigs at all.

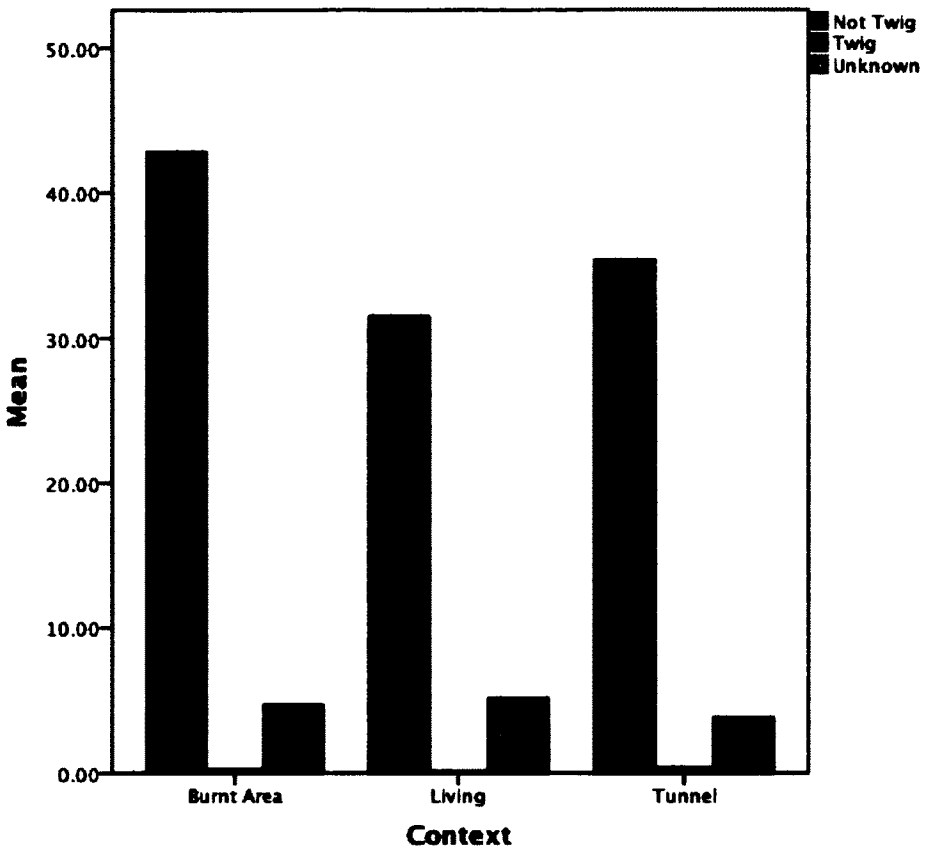


Figure 4.16: Twig to non-Twig ratio in Feature 68a.

Feature 33 Growth Curvature Comparison by Context

In comparing the contexts in Feature 33, a near statistically significant relationship was found between the burnt area and the living area (Tables A.38 and A.39). The burnt area, in other words, has more charcoal from local vegetation than the living area. The relationship between the burnt area and the tunnel was not statistically significant, or near statistically significant. Looking at Figure 4.17, it is clear that the majority of charcoal in Feature 33 still originates from driftwood, although the inhabitants were certainly using more local vegetation than the inhabitants of Feature 68a.

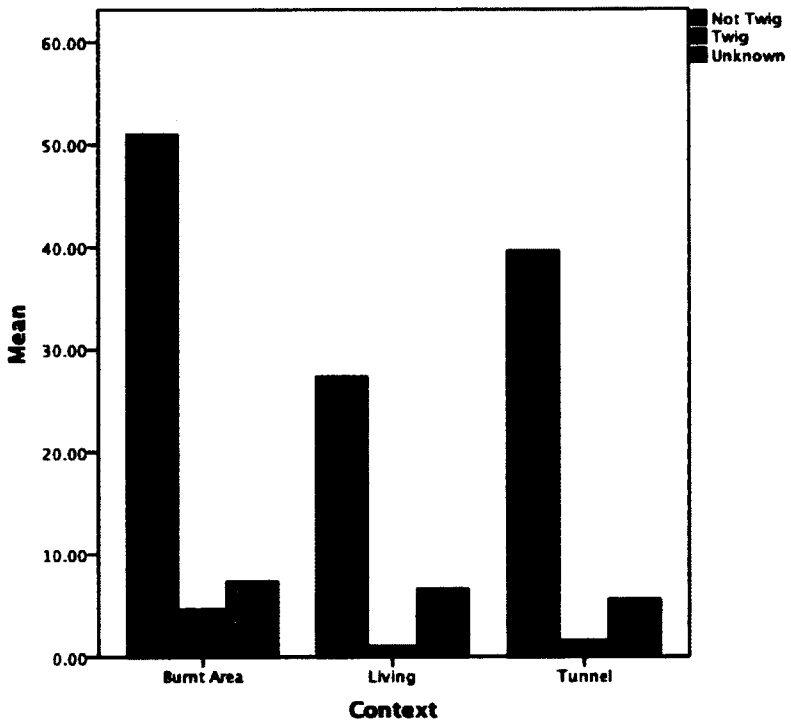


Figure 4.17: Comparing growth curve by context in Feature 33.

Comparing Growth Curvature between F-68a-1 and F-33-1

Looking at Figures 4.16 and 4.17, the differences between the burnt features of both houses are quite noticeable in terms of the quantity of local vegetation used. This relationship is statistically significant (Table A.40). The burnt area of Feature 33 has statistically significantly more twigs (mostly *Salix*) – local vegetation – than the burnt area of Feature 68a.

Comparing Growth Curvature between Living areas

The trend of Feature 33 containing more carbonized local vegetation continues in the living area as well. When the living area of Feature 68a and Feature 33 were compared statistically, it was found that there was a statistically significant

difference for twigs (Table A.41). Referring back to Figure 4.16 and 4.17 once more, it is easy to see that the living area of Feature 33 has more carbonized twigs than the living area of Feature 68a. Still, charcoal from driftwood overwhelming dominates the charcoal assemblage found in both living areas.

Comparing Growth Curvature between Tunnels

As seen in Figures 4.16 and 4.17, the tunnel of Feature 33 contains more twigs than the tunnel of Feature 68a. This difference, however, is not great enough to be statistically significant between house features (Table A.42). This is the only context in which Feature 33 does not have statistically significantly more charcoal from local vegetation than Feature 68a.

Chapter 5: Discussion of Macrofossil and Charcoal Results

Plant Taxa Recovered from Features 68a and 33

Plants Used in Feature 68a and 33

From the statistical and visual analyses above, several points of discussion arise. First, considering the macrofossil results, most samples had predominantly gramminoid (sedges and grasses) matrices, and the bulk of recovered macrofossils were found in samples dominated by grassy remains. The majority of macrofossil remains found in cultural contexts, and even in fill and off-site contexts, have documented cultural uses, whether their abundance is statistically significant or not.

Zutter (2009) demonstrated that looking at plant use by context could provide further insight into what plants were being used at a site, where they were being used and how they were being used. This information can help suggest what sorts of activities were being carried out at a site. Figure 5.1 shows Features 68a and 33 with six identified categories of plant use based on what is ethnographically known from historic and modern times (Oswalt 1957; Jones 2010; McIntosh 1999; Anderson 1939). These six categories are: strictly edible plants in blue, plants that are edible and have documented medicinal uses in green, plants that are strictly medicinal in brown, plants that have documented cultural uses but are not edible in red (primarily sedges), and finally, plants with no uses in teal and aquatic plants in yellow.

None of the aquatic plants identified, except *Hippuris*, have culturally documented uses, but it was important to separate the aquatic taxa to see where they were most abundant. It is possible that the aquatic taxa at Cape Espenberg represent modern contamination from flotation processes. *Hippuris* was not included in the aquatic category because it has documented ethnographic uses. Table 4.3 lists the plant taxa found in cultural contexts and their various uses.

Figure 5.1 shows each feature, and the distribution of plants within each context. The vast majority of plants in every context fall into the "Edible and Medicinal" category. Figure 5.1 also shows the relative uniformity of plant use in Feature 33 compared to the greater variety seen in Feature 68a. Observe that the tunnel of Feature 68a has the greatest abundance of non-edible plants with cultural uses ("Other Uses"), aquatic plants, and plants with no culturally documented uses.

The tunnel of Feature 68a has the greatest variety of plants with other uses, aquatic plants and plants with no ethnographically documented uses. The greater numbers of aquatic plants and plant with no uses could be from flotation contamination, inadvertent anthropogenic introduction by the inhabitants of that house, or possibly, these plant species were introduced when an earthquake shifted the tunnel of Feature 68a and its stratigraphy (note the clear break in the tunnel).

Remember that the tunnel of Feature 68a has more *Carex* (sedges) than the tunnel of Feature 33 at a near statistically significant level. Also, the burnt area of Feature 68a appears quite different from the other contexts within this house. In contrast, the contexts within Feature 33 are much more homogenous. This may

suggest that the burnt area in Feature 33 is indeed associated with the main occupation of the house, while the burnt area of Feature 68a is, in fact, unassociated.

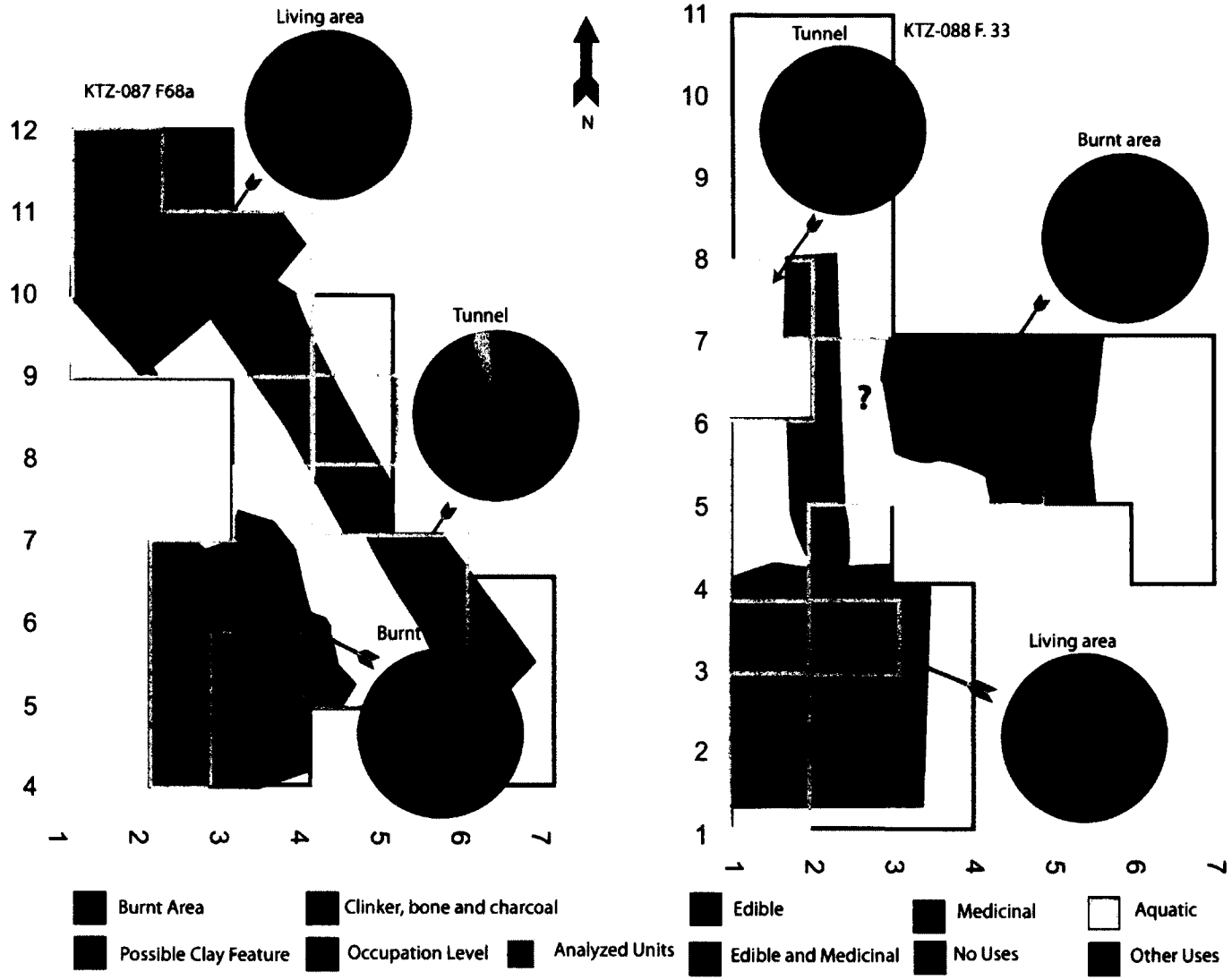


Figure 5.1: Plant Use by Feature and Context in Features 68a and 33.

During her survey of Cape Espenberg, Schaaf (1987) recorded that 67 different vascular plant species growing at the spit. About 52%, or 35 of the total species Schaaf found growing at Cape Espenberg, have documented cultural uses among the modern day Inupiat (Jones 2010, McIntosh 1999). Compared to the Napaskiak Yup'ik, using just 52% of the vascular plant species available on the landscape is a relatively low amount. The Napaskiak Yup'ik in southwest Alaska are known to have gathered and used 85% of the vascular plants growing on the landscape (Oswalt 1957: 18-19). Cape Espenberg may simply have fewer plants with documented cultural uses than other areas farther south in Yup'ik territory where biodiversity is higher. Biodiversity is generally higher further south in Alaska, and thus it is reasonable to assume the Yup'ik had access to a greater variety of plant taxa (Pielou 1994).

Many taxa recovered from Thule contexts at Cape Espenberg could only be identified to the genus or family level, and may contain a handful of species each. With species-specific identification typically being impossible in this study, there may be between 17 and 28 different plant species represented. It is impossible at this time to be more precise. A minimum of 17 taxa - about 49% of the 35 plant species with documented Inupiat uses growng at Cape Espenberg - and a maximum of 28 taxa, or about 80% of the 35 plant species, are found in the Thule house features at Cape Espenberg. Table 5.1 lists all of the vascular plants with documented cultural uses, and all of the taxa recovered from Features 68a and 33.

The minimum number of plant taxa used by the Thule at Cape Espenberg is more closely in-line with that of the St. Lawrence Islanders. Young and Hall (1969: 50) documented that at least 17 plant species were used for food, 3 for medicinal purposes, and about 10 species (they include driftwood species in this count) are used for fuel or other purposes such as house construction. It is likely that the Thule at Cape Espenberg had access to more species than the modern St. Lawrence Islanders because of the greater species richness and plant abundance on the mainland.

Ultimately, 25% - 42% of the available vascular plants growing today at Cape Espenberg are represented in the cultural samples from Feature 68a and Feature 33. These numbers imply that there is the possibility that plant foods were not as important to the Thule as they are to the modern day Inupiat, but in light of the nutritional value of plant foods, this seems unlikely. Perhaps the relatively low number of plant taxa recovered from Cape Espenberg is a result of taphonomy – especially in light of the fact that most macrofossil specimens could not be confidently identified to the species level.

Table 5.1: Cape Espenberg Species and Recovered Macrofossil Taxa.

Use	Species with Documented Uses at Cape Espenberg	Genera or Species with Documented Uses found in Features 68a and 33
Edible and Medicinal	*Angelica lucida*	-
	Empetrum nigrum	*Empetrum nigrum*
	Pedicularis lanata	-
	Pedicularis kanei	-
	Petasites hyperboreus	-
	Polygonum viviparum	*Polygonum* sp.
	Salix planifolia ssp. Pulchra	*Salix* sp.
	Vaccinium uliginosum	*Vaccinium* sp.
	Vaccinium vitis-idaea	*Vaccinum* sp.
Edible	*Arctostaphylos alpina*	*Arctostaphylos* sp.
	Betula nana	-
	Epilobium angustifolium	*Eriophorum* sp.
	Eriophorum angustifolium	*Eriophorum* sp.
	Equisetum arvense	-
	Hippuris vulgaris	*Hippuris* sp.
	Honckenya peploides	-
	Lathryus maritimus	*Lathyrus maritimus*
	Potentilla palustris	*Potentilla* sp.
	Potentilla villosa	*Potentilla* sp.
	Sedum rosea	*Rosaceae* sp.
Medicinal	*Artemisia Tilessii*	*Artemisia* sp.
	Ledum palustre	*Ledum* sp.
Other Uses	*Carex gmelini*	*Carex* sp.
	Carex rotundata	*Carex* sp.
	Carex saxatalis	*Carex* sp.
	Carex aquatilis	*Carex* sp.
	Carex lyngbyaii	*Carex* sp.
	Arctagrostis latifolia	*Poaceae* sp.
	Hierochloe alpina	*Poaceae* sp.
	Calamagrostis purpurascens	*Poaceae* sp.
	Festuca rubra	*Poaceae* sp.
	Leymus arenarius mollis	*Poaceae* sp.
	Poa alpigena	*Poaceae* sp.
	Poa eminens	*Poaceae* sp.
	Dupontia Fisheri	*Poaceae* sp.

Crowberry (*Empetrum nigrum*) is the single most abundant macrofossil in any sample taken from Cape Espenberg – regardless of context. *Empetrum nigrum* is one of the most abundant species growing at the cape. Furthermore, it is an edible plant also used for medicinal purposes (Jones 2010: 115-116; McIntosh 1999: 43). The high amounts of *Empetrum nigrum* in cultural samples reflect its use in cultural contexts. Both its ubiquity at the cape and its cultural usefulness may help explain its abundance in practically every cultural sample, and every fill or off-site sample. In both house features, crowberry leaves outnumber crowberry seeds except in the living areas. In Feature 33 the ratio between leaves and seeds is more equal, as there are 101 crowberry leaves per 150 ml, and 96 crowberry seeds. In the cultural contexts of Feature 68a there are a total of 228 crowberry leaves per 150 ml of sediment, and 107 crowberry seeds. The quantity of leaves may suggest that the inhabitants of these house features were consuming this berry. Or, the abundance of crowberry leaves, regardless of context, could simply represent the fact that crowberry plants typically have many more leaves than seeds.

It is important to mention that *Empetrum nigrum* seeds and leaves are robust and preserve well, while other macrofossil remains are much more fragile. Taphonomy thus at least partially explains its abundance. In many areas on Cape Espenberg crowberry (*Empetrum nigrum*) is the dominant species, or if not the dominant species, one of the most abundant species (Schaaf 1987). From the amount of crowberry retrieved from samples, it appears that crowberry was probably as abundant in Thule times as it is today.

Crowberry, although it is the most abundant taxon in cultural samples, is significantly less abundant in cultural contexts than in fill samples or off-site samples. The fact that the off-site contexts have significantly more crowberry than cultural contexts could suggest that the signature seen in the cultural samples is anthropogenic (that people were purposefully bringing *Empetrum* into the house features), and that the non-cultural samples reflect the abundance of *Empetrum nigrum* growing on the landscape. The relatively low concentration of *Empetrum* remains in cultural samples could also be the result of taphonomy. It is possible that shifting sands buried the cultural samples relatively quickly, and soon isolated these sediments from the natural abundance of *Empetrum* growing at the spit, preserving the relatively low Empetrum counts found in cultural samples.

The second most abundant genus in all of the cultural samples is *Carex* (sedges). Ethnographic literature documents the cultural use of *Carex* plants by the historic Inupiat and Inuit (Burch 2006). Oswalt (1957: 26) notes that the modern Napaskiak Yup'ik wove sedges into various items such as mats, socks and coarse sacks. At the prehistoric Ipiutak *qarigi* or men's house at Deering, remains of plaited mats were found placed on platforms (Larsen 2001:19). At Uivak in eastern Canada, Zutter (2009: 31) found a high percentage of sedge seeds on the floor, which were presumed to be the remains of woven mats. At Cape Espenberg there was no evidence of grass mats, but it is possible that the inhabitants were using and making grass mats. Alternatively, the inhabitants could have been putting down loose sedges as a floor covering.

Ethnographically, it is known that the Inupiat would braid grasses or sedges into long rows linked together in order to make sleeping mats, or placed on top of willow-covered floors. Grasses would be used to line meat storage pits and insulate houses. Modern Inupiat in certain areas would braid grasses into baskets, or use grass as insulation in their boots (Burch 2006: 191, Anderson et. al. 1988: 305). Any of these ethnographically known uses could explain the abundance of sedge remains in Features 68a and 33.

The next genera in abundance are *Vaccinium* and *Potentilla*. These two genera are consistently either third or fourth in abundance in most cultural samples. The genus *Vaccinium* contains two species, low-bush cranberry (*Vaccinium vitis-idaea*) and bog-blueberry *(Vaccinium uliginosum*). Both species are locally abundant, nutrient rich and delicious edible berries (Jones 2010: 50, 104; McIntosh 1999: 48, 55). Seeds and leaves of both of these plants were found in cultural remains. The Thule at Cape Espenberg, like their Inupiat descendants, probably enjoyed and took advantage of these fruits, and may have made *Potentilla* tea as discussed above.

Salix is also fairly abundant. The genus *Salix* contains a number of species, but the fragmentary nature of the leaves and seeds made it impossible to identify the macrofossil remains to this level. *Salix* seeds are also small and do not preserve well. Several species of *Salix* are edible, but the most commonly eaten (and tastiest) species is *Salix pulchra.* This species grows at Cape Espenberg today, and its leaves called *sura* by the Inupiat, contain high amounts of vitamin C (ten times that of oranges), vitamin A and calcium (Jones 2010: 11). It is possible that the *Salix*

specimens found in the cultural samples represents the consumption of *sura* by the Thule inhabitants.

Alternatively, the high quantities of *Salix* leaves, buds and bud scales could have come from shrubs brought into the house to be used as floor coverings (Burch 2006: 191). In all likelihood, the quantity of willow probably comes from a combination of these methods of introduction. Carbonized woody *Salix* remains were found in the both houses, as discussed below. The only areas that contain no uncharred *Salix* remains are the tunnels, which is interesting because *Salix* was used historically for covering floors. This may reinforce the hypothesis that the inhabitants of Cape Espenberg were relying more heavily on gramminoids as floor coverings – especially in the tunnels.

Empetrum nigrum, *Carex*, *Vaccinium*, *Potentilla* and *Salix* make up nearly 90% of the identifiable items in cultural samples. *Eriophorum* and *Hippuris* make up a substantial portion of the last 10%, and all of the remaining 21 identified taxa only occur in very small quantities.

One species of *Eriophorum*, *Eriophorum angustifolium*, called *pitniq* by the Inupiat, is edible. This resource is traditionally gathered from rodent caches during the fall (Jones 2010: 148-149; McIntosh 1999: 49). Young *Hippuris* plants are also edible, but only the seeds of this plant remain preserved in archaeological contexts. Still, the presence of both of these taxa in cultural contexts could suggest that the inhabitants of Feature 68a and Feature 33 were consuming these plant foods.

Eight macrofossil taxa do not have documented cultural uses. Six of these macrofossil taxa (*Andromeda* sp., *Apiaceae* sp., *Asteraceae* sp., *Cerastium* sp., *Montia* sp., and *Sparganium Hyperboreum*) are found in the tunnels of both houses. The tunnel is an interesting area in both houses because it is the only way into and out of the house, and thus it is the only way plant matter can enter or exit the house. The only two non-cultural genera not found in the tunnel but found in the burnt features or in the living areas, are *Juncus* (one seed in one sample) and *Andromeda* leaves, which are robust and preserve well. The species of *Andromeda* that grows at Cape Espenberg, *Andromeda polifolia*, commonly called Bog Rosemary, is poisonous (Schaaf 1987; Jones 2010: 158). These specimens were most likely inadvertently introduced into the house.

So, while most macrofossils have cultural uses, the smaller number of taxa without documented cultural uses suggests that plants may have been inadvertently dragged into the house, perhaps through the tunnel. Inadvertent introduction of non-cultural taxa could explain why the tunnel has so many more non-cultural species than the burnt features or living areas. Alternatively, the Thule at Cape Espenberg could be using these plant species in ways that have not been documented among the modern Inupiat.

Noticeably, there are low quantities of some key edible plants in the house features. Most glaring is the lack of significant amounts of cloudberry (*Rubus chamaemorus*). In the summers of 2010 and 2011, cloudberries were nearly as abundant as cranberries (*Vaccinium vitis-idaea*) and blueberries (*Vaccinium*

uliginosum) on the landscape. If we assume that the vegetation of Cape Espenberg has not changed significantly since Thule times, there should be more cloudberry remains in the houses.

Jones (2010: 82) asserts that cloudberry is the most preferred berry of the Inupiat because (1) they are the first berries to ripen, (2) they are big, delicious and easy to pick and (3) because they keep well throughout the winter. Cloudberries are also very nutritious, and contain significant amounts of vitamin C and fiber. In historic times, cloudberries were one of the most important sources of these nutrients (Jones 2010: 82, 84). Since there are some cloudberry remains in the house we can assume that the Thule inhabitants were eating these berries.

The relative lack of this important berry might be the result of several scenarios. First is the unlikely scenario in which the Thule did not eat very many cloudberries. This scenario is unlikely because of the reasons listed above. If the Thule at Cape Espenberg were consuming cloudberry as much as their Inupiat descendants, perhaps the low frequencies of cloudberry remains in cultural contexts reflect their value as a food source. Whereas crowberries are supra abundant on the landscape, cloudberries are not, and are thus more time consuming to gather. Perhaps the inhabitants were more careful to not drop and lose fresh cloudberries once they were brought into the house, whereas a crowberry dropped onto the floor may go unnoticed.

Another scenario is that the Thule were storing and preserving their cloudberries in a similar fashion to their Inupiat descendants – that is, they were

keeping their cloudberries fresh and preserved throughout the winter by storing them alone or with other greens and berries in seal pokes in cold storage cache pits, sometimes by immersing them in seal oil (Jones 2010: 83; McIntosh 1999: 41). Thus, perhaps fewer fresh cloudberries were brought into Thule houses for consumption.

Since cloudberries are such a valued berry today, and because there is some evidence they were being eaten at Cape Espenberg, the Thule may have been storing a lot of their edible greens and berries in cache pits just like the historic Inupiat. Unfortunately, no cache pits were excavated during the CEP. In the future it would be beneficial to sample and analyze the macrofossil remains of a Thule cache pit.

A final possibility is that the lack of cloudberries could reflect seasonality. Since it was one of the first berries to ripen at the cape, and since there are so many crowberries in each house (which ripen significantly later than cloudberries), its absence could reflect that Features 68a and 33 were not inhabited until the late summer or early fall, sometime after cloudberry had ceased to be widely available on the landscape. Notably, Feature 68a has only a few cloudberry seeds and Feature 33 has none. This relationship is not statistically significant, but could suggest that Feature 68a was inhabited earlier in the summer season than Feature 33.

The apparent dearth of *Arctostaphylos rubra* or *Arctostaphylos alpina* berries – bearberries – in the houses probably has a similar explanation. Both species of bearberry are edible and perfectly safe to eat, but neither has a good taste when eaten fresh (Jones 2010: 123, 133; McIntosh 1999: 47). Bearberries are traditionally

stored in seal oil, fish oil, or bear fat. The longer they remain in the oil or fat, the sweeter and softer they become. By springtime, these berries are very good to eat (Jones 2010: 123). So again, the small amount of bearberries and cloudberries found in the houses may not imply that the Thule inhabitants were not eating these berries. Instead, it may suggest they were preparing and storing these berries for winter consumption.

Unlike bearberries, crowberries (*Empetrum nigrum*), cranberries (*Vaccinium vitis-idaea*) and blueberries (*Vaccinium uliginosum*) are frozen or preserved in seal oil for winter consumption by the modern Inupiat, but are also good to eat fresh (Jones 2010; McIntosh 1999). The abundance of crowberry, cranberry and blueberry seeds in the houses may reflect the late summer and early fall consumption of freshly picked berries.

Wood as Fuel at Cape Espenberg

Like the ethnographically known Inupiat, the Thule at Cape Espenberg appear to have selected gymnosperms – more specifically *Picea,* for firewood. In Feature 68a and Feature 33, every context contains more than 50% gymnosperm charcoal fragments (See Figure 4.4). While *Picea* constitutes about 61% of the charcoal fragments recovered, *Salix* is a distant second at 14% (See Table 4.6).

Salix and *Populus* make up 40% of Northwest Alaska's driftwood accumulations (Alix 2008: 45). Dwarf willow species also grow abundantly at Cape Espenberg (Schaaf 1987). Shrubby willow, like other woody shrubs, has been used

as kindling in modern and historic times (Smart and Hoffman 1988: 168). Since it was relatively abundant in local driftwood accumulations and on the landscape, *Salix* appears to have been used as fuel regularly – although *Picea* was used in much greater quantities.

Noticeably absent from the angiosperm assemblage is *Populus*. Burnt *Populus* only makes up only about 2% of the total charcoal sample even though *Populus* was used in the construction of Thule houses at Cape Espenberg, and is deposited in relatively large quantities in local driftwood accumulations. Other infrequently found taxa include birch and crowberry charcoal. Birch (*Betula*) makes up only about 1% of the entire charcoal composition of both sites. Charcoal specimens from the *Empetraceae* family are always crowberry (*Empetrum nigrum*) when they can be identified to the species level. *Empetraceae* charcoal makes up 0.7% of the overall charcoal assemblage. As stated previously, birch does not survive the driftwood deposition process well, and is often a less frequently used fuelwood (Alix 2009a: 189; Anderson et. al. 1988: 238-239), and so it is not surprising it was only burned in small quantities. *Empetraceae* was burned in limited amounts as well, perhaps because driftwood was the preferred woody fuel source, and also because *Empetrum* plants at Cape Espenberg remain fairly small and procumbent, making it a less attractive woody plant to gather and burn.

Reconstructing Thule Plant Use at Cape Espenberg

Macrofossils: Statistics and Ethnography - Fill, Off-Site and Cultural Samples

In addition to a discussion about what was recovered from each site and in what quantity, the statistical data must be considered. For macrofossils, there are statistically significant differences between the cultural samples and the off-site samples, but no statistically significant differences between the cultural and fill samples, or between the fill and off-site samples. This same pattern is repeated when testing for sample richness; the cultural samples were significantly less macrofossil rich than the off-site samples, but the fill samples did not differ statistically from either the off-site or the cultural samples. The cultural samples, however, are quite a bit more diverse than either the fill samples or the off-site samples. While the cultural samples had 26 taxa, the fill samples had 15 and the off-site samples contained only 11 (see Table 4.2). At least in this case, the fill samples seem to be more similar to the off-site samples.

This information suggests that the macrofossils found in cultural contexts were anthropogenically introduced, either intentionally or unintentionally, and that the off-site samples reflect the abundance of natural vegetation on the landscape. The fill samples come from disturbed areas. Forbes (1996: 152) found that both Thule sites up to 1,000 years old and 20-year-old Inuit sites had similar types of plant vegetation. This suggests that there are an extremely limited number of tundra species that are able to colonize disturbed areas. The fact that Thule sites show the

similar plant communities to the 20-year-old sites suggests that these colonies of disturbed patches may persist for an indefinite period of time (Forbes 1996: 152). Mason (1990: 142) records that sites fewer than 1,000 years old are usually completely vegetated with crowberry, or willow and grass. Perhaps then fill samples are not a good measure for comparing against cultural samples, especially since they may not represent the natural tundra vegetation in undisturbed locations.

Macrofossils: Statistics and Ethnography - Within Feature 33 and Feature 68a

Comparing macrofossils from different contexts within Feature 68a and Feature 33 (the burnt area, living area and tunnel) with ANOVA tests revealed some statistically significant differences. Combined with visual analyses, it is possible to get an idea of how non-woody plants were being used in these two house features. Attention to context, taxa, and what parts of the plant remain are key to understanding the data.

The tunnels of both houses are interesting areas because of the diversity of taxa, the statistical differences between the tunnels themselves, and because of the differences between the tunnels and the other contexts within these house features. The greater abundance of *Potentilla* in the tunnel compared to the burnt feature seems counter-intuitive. If the inhabitants were making *Potentilla* tea it would make more sense if there were more *Potentilla* remains in the burnt feature or living area where the leaves would be boiled to make tea. This is not the case. Most of the *Potentilla* remains found in the tunnel of Feature 33 are seeds, however, and not

leaves. Perhaps this means that the inhabitants of Feature 33 were shaking the seeds off of the plant while bringing it in through the tunnel.

In Feature 68a, ANOVA tests also show that the tunnel contains statistically significantly more *Carex* and *Ledum* remains than the burnt feature, F-68a-1, and near statistically significantly more of these remains in the other contexts within this house. The abundance of *Carex* may suggest that the inhabitants of this house feature were lining the dirt floor of their tunnel with loose sedges, or braided sedge mats for insulation and/or floor covering (Burch 2006: 191).

While the tunnel floor of Feature 33 is lined with a single, finely hewn driftwood planks, the tunnel of Feature 68a has a dirt floor. An ANOVA test shows that the tunnel of Feature 68a has more *Carex* (near statistically significant) than the tunnel of Feature 33. This meets expectations considering the different construction of these two tunnels; the inhabitants of Feature 68a may have wanted to line and insulate the dirt floor of their tunnel, and perhaps they did so with sedges. The inhabitants of Feature 33 would not have had to have used sedges as much because of the fine wooden floor of their tunnel.

The other difference is that the tunnel of Feature 33 contains significantly more crowberry than the tunnel of Feature 68a. Crowberry ripens late in the growing season, so the abundance of crowberry in the tunnel perhaps indicates a late summer, early fall occupation of Feature 33, and a concentration on gathering and consuming fresh crowberries. Feature 68a contains less crowberry, but also more cloudberry. This may indicate that Feature 68a was occupied earlier in the

summer months since cloudberry is the first berry to ripen at Cape Espenberg every summer (Jones 2010). Neither house has many cloudberry seeds, but Feature 68a does have appear to have slightly more. This relationship is not statistically significant, however, so making firm conclusions on what this pattern means is difficult.

Charcoal: Statistics and Ethnography

Statistically speaking, feature 33 and feature 68a are similar in terms of charcoal species composition. This suggests that the availability of different woody fuel species, including driftwood and locally growing shrubs, was similar during the occupation of both houses. Additionally, this information suggests that the Thule inhabitants of both houses were gathering these different species in similar quantities.

The similarities between these houses suggests something about the availability of different types of wood at Cape Espenberg, and also what woods were being selected for fuel. From this data, we can assume that the composition of driftwood and woody shrubs at Cape Espenberg changed very little between the occupations of Feature 68a and Feature 33, even though these houses could have been occupied several hundreds of years apart. This data also suggest that the fuel wood preference of the Thule at Cape Espenberg remained largely the same. Of course, fuel wood preference also depends on what wood is actually available.

Dried *Picea* is a preferred fuelwood in modern times when a hot, clean burning fire is desired (Anderson et. al. 1988: 238-239; Deo-Shaw 2008). At other Thule sites, the inhabitants also appear to have had a preference for *Picea* (Alix 2003: 203). The abundance of spruce in the house features is also partially due to its abundance in driftwood accumulations (Alix 2005, 2008).

In general, the burnt areas of both houses contain more angiosperm fragments than other contexts within these house features. Feature 33's burnt feature, however, contains significantly more angiosperm wood than Feature 68a's burnt feature. Feature 33 also has more undifferentiated angiosperms than Feature 68a. This means that there were more angiosperm charcoal fragments that could not be identified to a specific taxon. Of the angiosperm fragments that could be identified, *Salix* is the most abundant angiosperm taxon within the burnt features of both houses, probably because it is relatively abundant in local driftwood assemblages, but also because it grows locally in the area.

Ethnographically it is known that the Inupiat would resort to collecting wood from locally growing willow (*Salix* sp.) shrubs when driftwood supplies had been exhausted (Heizer 1963: 191). The burnt feature of Feature 33 is very deep, but the charcoal remains in the burnt features of both houses represent the last few times a fire was lit (Heinz and Thiébault 1998: 57). The last few fires that were lit in Feature 33 incorporated relatively high quantities of *Salix*. It seems that the inhabitants of Feature 33 were relying more heavily on this lesser used fuel source in lieu of *Picea* wood. Additionally, much of the *Salix* used in the final fires were from local shrubs.

Feature 33-1 has significantly more twigs than Feature 68a-1 as indicated by an ANOVA test, and thus the last few fires in F-33-1 incorporated significantly more local vegetation than the last few fires lit in F-68a-1.

Historically, if local fuel supplies were used up, a group would be forced to move or splinter off into smaller groups (Heizer 1963: 191). Perhaps after resorting to *Salix* shrubs to supplement their last fires, the inhabitants of Feature 33 moved on to find an area with more abundant woody fuel supplies. Interestingly, Feature 33 was one of the very few inhabited Thule houses at Cape Espenberg after AD 1700 (Mason and Gerlach 1995b: 117). During this period of time, Cape Espenberg had begun to depopulate (Mason 2009: 116). By the turn of the 20th century, Cape Espenberg had been totally abandoned, but it appears that this abandonment was a slow process that took place over the course of centuries (Burch 1998: 287).

The declining deposition of driftwood on the shores of Cape Espenberg has been cited as one of the reasons why the area was ultimately abandoned (Wisniewski and Weyouanna 2010, personal communication). Today, the amount of driftwood at Cape Espenberg is relatively low when compared to other areas in the region (Alix 2011, personal communication). The fact that the inhabitants of Feature 33 burned willow shrubs during their last days occupying the house might support the idea that the dwindling availability of driftwood helped contribute to the declining resident population at Cape Espenberg.

Driftwood, however, still dominates the charcoal assemblage in every context in each house. An alternate explanation is that the abundance of *Salix* in F-33-1 may

simply indicate a winter occupation. In historic times, the inhabitants of Kivalina, Alaska would collect driftwood logs during the summer and save them for winter use (Saario and Kessel 1966: 972). In the winter, however, local willow shrubs were used for firewood to a much greater extent than driftwood.

Another possible scenario is that the inhabitants of Feature 33 could have chosen smaller diameter, shrubby wood as a way to control the height of the flames, the heat and the brightness of their fire (Dufraisse and Martinez 2011: 15). There is evidence to suggest that the ethnographic preference for boiled meat was a way to conserve fuelwood. By boiling meat in small ceramic containers, only a small fire would be needed for cooking (Frink and Harry 2008: 113).

Whereas the relative abundance of *Salix* in F-33-1 could suggest several economic possibilities, the lack of another taxa, *Populus*, could suggest something about seasonality. *Populus* is a good fuelwood for smoking fish in the summer, for instance (Alix and Brewster 2004: 7), but not especially good for giving off heat. The Ingalik Athapaskans burned *Populus* and *Salix* in their houses primarily during the springtime when less heat was required (Smart and Hoffman 1988: 168). The lack of *Populus* and the abundance of *Picea* could suggest a winter occupation of the site. Ethnographic information also reveals that cottonwood (*Populus balsamifera*) was known to leave a heavy ash, and was not favored as a firewood by some Alaskan Inupiat populations. Its ashy properties, however, did make it useful in the summer for repelling mosquitoes (Burch 2006: 187).

Interestingly, a relatively low amount of *Populus* was found in two 13th-

century assemblages and a late 15th century charcoal collection at the Alaskan Thule site of Uivvaq, north of Cape Espenberg (Alix 2008). Further east in the Arctic, Jenness (1922) reports that the Copper Inuit were wary of burning cottonwood, for fear that it would bring bad weather. Thus, the lack of *Populus* could reflect cultural norms in addition to seasonality.

There is also a low amount of *Betula* in either house feature. First, *Betula* logs do not survive the driftwood deposition process very well. They often rot before reaching the sea, and then are damaged when delivered onto beaches. They usually arrive in a poor state of preservation (Alix 2009a: 189), making *Betula* driftwood less suitable for fuelwood. Because birch is poorly preserved in driftwood accumulations, it was probably not very attractive to the Thule at Cape Espenberg as a fuelwood. Uncharred *Betula* remains are also noticeably absent in the cultural macrofossil assemblage. This may suggest that the Thule at Cape Espenberg were ignoring *Betula*, perhaps because birch wood does not typically preserve well in the driftwood deposition process.

The fact that *Empetraceae* was burned makes sense considering the abundance of crowberry at the site in the form of seeds, leaves, buds and stems. No known ethnographic sources point to a reliance on *Empetraceae* for fuel, so its low presence in the charcoal assemblage matches ethnographic expectations. It should also be noted that most burnt *Empetrum nigrum* and *Empetraceae* twigs were found directly in the burnt areas of each house feature. Their survival suggests that this plant was not used as a fire starter, but was probably added on later to an already

established fire. Perhaps *Empetrum nigrum* plants that were brought into the house for consumption were disposed of in the fire after the berries had been gathered or eaten.

Additional Fuel Sources: Bones and Blubber

Feature 68a and Feature 33, statistically speaking, are largely the same in terms of the presence of fatty residues on charcoal fragments. The burnt areas of both houses, however, have significantly more charcoal fragments with fatty residue present than any other context within either house. This fatty residue saturation could originate from cooking activities over the burnt features, but this seems unlikely because boiling – not roasting – was the preferred method of meat preparation among the historic Inupiat, and presumably among the Thule as well (Burch 2006: 226).

Another possibility is that fatty sea mammal bones (calcined bones were abundant in both hearths) were being used as fuel in conjunction with wood, and/or were being discarded in the hearth. Perhaps the fat from the burnt bones accounts for the fatty residue found throughout all of the charcoal samples.

Bone is an excellent fuel source, and has been used in ethnographic times by Inuit peoples. Birket-Smith (1929: 98) reports that eastern Inuit groups would burn bone and blubber when their usual fuel sources, driftwood and *Cassiope tetragona,* were unavailable. At the Alaskan Uivvaq site there were only low amounts of charcoal, but there was abundant evidence that bones were a significant source of

fuel for the prehistoric occupants of this site (Alix 2003: 197). Thus, both ethnographic and archaeological data exists that suggests that bone was used as a fuel source in the Arctic – especially when woody fuel was scarce or unavailable.

The abundance of calcined bone in both F68a-1 and F33-1 suggest fuel conservation behaviors. Experiments conducted by Théry-Parisot (2001: 111) show that fire duration can be extended with the addition of bone. Although the length of combustion can be prolonged with bone comprising as little as 15% of the fuel weight, maximum fire burning time is achieved with a composition of 20% wood and 80% bone in relation to total fuel weight (Théry-Parisot 2001: 111). In the burnt area of Feature 33, the ratio was nearly 50/50 – at least in terms of number of fragments. For this burnt feature, the weights of the bones and the charcoal were not taken.

There is a final possibility that could explain the consistent fatty saturation of charcoal. Perhaps the inhabitants of Cape Espenberg were deliberately adding fat or blubber to their fires in order to stretch their fuel resources and extend the life of their fires, much as the Inupiat have done in modern and historic times (Saario and Kessel 1966: 972). Combining the correct amounts of fat and wood can extend the life of a fire considerably, and if woody fuel resources were indeed declining, burning animal fat may have been an attractive way to conserve woody fuel.

The abundance of bone and fatty residue could have implications for the state of woody fuel availability at Cape Espenberg during the final days of inhabitation at Feature 33. Combined with the knowledge that the last few fires in F-

33-1 were supplemented by a statistically significant abundance of angiosperm taxa from locally growing shrubs, the data could suggest that the inhabitants of Feature 33 were practicing fuel conservation, perhaps because of limited or declining driftwood availability.

Gathering and Behavioral Ecology

Fuelwood

The ways in which the Thule at Cape Espenberg were exploiting local plant and wood resources fits into a larger model of plant and wood use by mobile hunter-gatherer populations. The behavior evidenced at Cape Espenberg, as far as fuel and plant use are concerned, matches established behavioral ecology models. As outlined by Deo-Shaw (2008) concerning modern driftwood procurement optimization, the Thule appear to have had similar optimization strategies as modern Alaskan natives on Kodiak Island.

Like other hunter-gatherers who practice residential mobility, the Thule at Cape Espenberg probably aimed to expend the least amount of energy for the greatest energy return. Gathering wood for fuel is an economic activity that one ideally attempts to optimize in order to maximize returns (Deo-Shaw 2008: 75). Fuelwoods are gathered according to their known combustible properties and rationally, the wood fuel gatherers factor in the efficiency of handling costs when they select different types of wood (Deo-Shaw 2008: 97). This includes calculating the energy return the wood yields in relation to the energy expended on the round-

trip travel time, added to the effort needed to convert fuelwood into a useable form (Deo-Shaw 2008: 76).

While large pieces of driftwood may yield a large amount of fuel, the handling costs in transporting and cutting large driftwood logs are high. Gathering copious amounts of shrubbery may not have expensive preparation costs, but may be too time intensive for their limited caloric yield. Ultimately, finding a balance that optimizes energetic returns is ideal (for instance, gathering smaller driftwood). In cases where fuel supplies have been depleted, individuals must expend more time and effort either in gathering or preparing fuel in order to yield the same caloric output (Alix 2009a: 196; Deo-Shaw 2008).

The Thule may have planned their movements far in advance, taking note of where fuel supplies were most abundant, and storing woody fuel in those locations when it was available, much like the modern Evenki of Siberia (Henry et. al. 2009). Driftwood, the main fuel source at Cape Espenberg, could have been gathered during the summer months and stored in anticipation for a winter return to the area.

Edible Plant Optimization

Similar advanced planning could be practiced with plant foods. Gathered in the summer, the Thule could have stored their greens and berries in seal oil so that they could be consumed during the hungry winter months. The Thule likely optimized their plant gathering behavior much like the modern inhabitants of St.

Lawrence Island. As discussed previously, cloudberries (*Rubus chamaemorus*) are one of the most important plant foods to the modern Inupiat (Jones 2010: 82). However, on St. Lawrence Island cloudberry plants produce so little fruit that gathering this berry for more than just casual consumption is more trouble than it is worth (Young and Hall 1969: 45). So, even though cloudberries are available, nutritious and delicious, the inhabitants of St. Lawrence Island focus more on gathering other plant resources that provide a greater energetic yield (Young and Hall 1969: 45).

At Cape Espenberg, the large quantities of *Empetrum nigrum* in cultural settings suggests that the Thule here took advantage of this abundant resource, even though it is not one of the best-tasting berries available on the landscape. While the inhabitants had access to *Vaccinium vitis-idaea*, *Vaccinium uliginosum* and *Rubus chamaemorus,* the overwhelming abundance of *Empetrum nigrum* could suggest ecological optimization. It is, after all, one of the most common species on the landscape, if not the most common. Energetically, it makes more sense to gather large amounts of *Empetrum nigrum* instead of spending greater amounts of time looking for tastier berries.

The abundance of sedges in cultural contexts may also be a reflection of optimization strategies. Burch (2006: 191) notes that the ethnographically known Inupiat would line their floors with willow. While willow is found in cultural contexts, sedges are much more abundant, and as mentioned previously, constitute the dominant matrix of almost every macrofossil sample analyzed in this thesis.

Sedges and grasses grow much more abundantly at Cape Espenberg than willow, and the willow shrubs do not often grow higher than half a meter tall. Energetically speaking, it would be much more time efficient to gather grasses than willows simply because grass and sedge species grow so abundantly on the landscape – especially in the lower lying, wetter swales. Using sedges and grasses to line and insulate the floors of Feature 68a and Feature 33 would be energy efficient in terms of time spent gathering the needed resources, but would also effectively replace the need to use willows as floor coverings.

A Comparison of Cape Espenberg, Alaska to Uivak, Labrador

Although macrofossil studies have been carried out at a few archaeological sites in the Arctic, the only closely comparable study is Zutter's 2009 study at the 18th century Thule era-site of Uivak in Labrador. Since Uivak and Cape Espenberg are the only locations where studies have dealt specifically with Thule plant use, it is valuable to compare and contrast the results of each study. Zutter sampled the floor, entranceway, sleeping platform and midden of a single Thule era house, similarly to how different contexts were sampled within the two Thule era houses in this study. Zutter sampled by context in order to compare and contrast contexts, and reveal any discrete activity areas. Like at Cape Espenberg, Zutter also took off-site samples at Uivak for comparison against cultural samples.

There are some noticeable differences between this thesis and Zutter's study. Importantly, Zutter did not analyze charcoal remains in addition to uncharred

macrofossil remains, nor did she incorporate any statistical analyses. Secondly, the environment of the Uivak site is quite different than the environment of Cape Espenberg. While the Uivak site is at treeline, Cape Espenberg is about 100 km from treeline (Zutter 2009; Mason 1990: 116).

In all, Zutter (2009: 24) recovered over 15,500 plant macrofossils from 26 different taxa. Note that this count includes woody taxa (such as *Picea*) as well as non-woody taxa. It should be mentioned, however, that about 10,000 seeds in Zutter's study came from a single human coprolite. If this outlier is eliminated, Zutter recovered 5,000 plant macrofossils in her 28 samples - roughly half the number of macrofossils recovered from the 60 macrofossil samples analyzed from Cape Espenberg.

For this thesis, 9,518 non-woody macrofossils representing 26 taxa were recovered. If the charcoal taxa are included in the total taxa count, 35 total taxa were identified at Cape Espenberg. If the 1,617 analyzed charcoal pieces are included in the total count, 11,135 macrofossil specimens in all were identified from the 60 samples analyzed for this thesis. Therefore, the total sample richness, excluding the coprolite sample, may be similar between the Uivak and Cape Espenberg sites.

The abundance of macrofossils in the human coprolite requires that sample richness receive more attention. Zutter measures macrofossil abundance per liter while this thesis measured macrofossil abundance by 150 ml. In order to compare the macrofossil richness at Cape Espenberg to the macrofossil richness at Uivak, the macrofossil counts need to be standardized to 1-liter units. Table 5.2 shows that the

cultural samples from Cape Espenberg have average macrobotanical concentrations of about 123/liter, that the fill samples have about 1,275/liter and the off-site samples have about 5,123/liter. Note the high standard deviations however; the upper fill and upper off-site samples contained more macrofossils than did lower levels, although not to a statistically significant degree.

Table 5.2: Macrofossil Concentration per 150 ml and per liter at Cape Espenberg.

Sample Type		Macrofossils per 150 ml	Macrofossils per Liter
Cultural	Mean	18.46	123.1
	No. of Samples	37	37
	Std. Deviation	26.36	175.78
Fill	Mean	191.24	1274.94
	No. of Samples	13	13
	Std. Deviation	287.06	1913.78
Off-Site	Mean	344.71	2298.12
	No. of Samples	10	10
	Std. Deviation	768.39	5122.64
Total	Mean	110.27	735.17
	No. of Samples	60	60
	Std. Deviation	351.13	2340.91

At Uivak, the off-site samples had very low concentrations of macrofossils, averaging about 20/liter. The on-site samples had significantly higher average macrofossil concentrations at about 300/liter (Zutter 2009: 24). The reasons why Zutter's off-site sample concentrations are so low while the Cape Espenberg samples have such high concentrations are unknown. It is possibly an issue of taphonomy.

For the cultural concentrations, however, Uivak's may be higher because of the human coprolite, and/or because of the abundance of white spruce (*Picea glauca*) needles at Uivak used to provide bedding for the sleeping platform (Zutter 2009: 25). Since there are no live spruce trees to exploit at Cape Espenberg, this could explain why the cultural macrofossil count is lower in Features 68a and 33. Furthermore, at Uivak, there are far more plant species that can be used for bedding than at Cape Espenberg. At Uivak the inhabitants used *Abies* sp., *Larix* sp., *Juniperus* sp., *Picea glauca, Picea mariana, Alnus viridis, Betula nana* and *Populus* sp. leaves and needles for bedding while the inhabitants of Cape Espenberg seemed to have only used sedges and grasses. This may help explain why the cultural contexts at Uivak contain more macrofossils per liter than at Cape Espenberg.

For the sake of comparison, Zutter's (2009: 29) raw macrofossil data from Uivak was placed into the categories used for this thesis, and compared to the visual contextual analyses from Cape Espenberg in Figures 5.1 and 5.2. Table 5.3 below lists taxa by use category for Cape Espenberg and Uivak. By putting Zutter's macrofossil taxa into the categories used in this thesis using Zutter's ethnographic data, it is much easier to compare Uivak to Cape Espenberg. The contexts at Uivak and Cape Espenberg, however, are somewhat dissimilar.

Table 5.3: Plant Use Categories for Uivak and Cape Espenberg

Use	Species with Documented Uses at Cape Espenberg	Species with Documented Uses at Uivak
Edible and Medicinal	*Empetrum nigrum*	*Empetrum nigrum*
	Polygonum sp.	-
	Salix sp.	*Salix* sp.
	Vaccinium sp.	*Vaccinium* sp.
Edible	*Arctostaphylos* sp.	*Arctostaphylos* sp.
	Eriophorum sp.	-
	Hippuris sp.	-
	Lathyrus maritimus	-
	Potentilla sp.	-
	Rosaceae sp.	-
Medicinal	*Artemisia* sp.	-
	Ledum sp.	-
Other Uses	*Carex* sp.	*Abies* sp.
	Poaceae sp.	*Larix* sp.
	-	*Juniperus* sp.
	-	*Picea glauca*
	-	*Picea mariana*
	-	*Alnus virdis* spp. *Crispa*
	-	*Betula nana*
	-	*Populus* sp.
	-	*Elymus arenarius*
	-	*Juncus* sp.
No Known Uses	*Andromeda* sp.	*Capsella bursa-pastoris*
	Apiaceae sp.	*Cerastium* sp.
	Asteraceae sp.	*Eleocharis* sp.
	Caryophyllaceae sp.	*Galium* sp.
	Cerastium sp.	*Silene* sp.
	Juncus sp.	*Stellaria* sp.
	Montia sp.	*Montia* sp.
	Sparganium hyperboreum	-

Despite the differences between context at Uivak and Cape Espenberg, some comparisons by context can be made. Zutter (2009: 24) notes that the house floor, sleeping platform and entrance way samples – contexts akin to the living area and tunnel samples at Cape Espenberg – are dominated by woody plant macrofossils like *Empetrum nigrum* and *Betula nana* leaves and twigs. Like at Cape Espenberg,

Empetrum nigrum is the single most abundant taxa at Uivak (Zutter 2009: 24). Little *Betula* was found in cultural contexts at Cape Espenberg, however. As discussed previously, both local shrubby birch and driftwood birch are available at Cape Espenberg, but the inhabitants of Features 33 and 68a seem to have not been using it, for one reason or another – perhaps an unknown cultural reason.

At Uivak, sedges were found in both the entranceway and house floor. Zutter (2009: 31) postulates that these sedge remains could be the remnants of grass mats used to absorb odors and insulate the house. There are no ethnographic examples of sedge mats being used in the Western Arctic for odor control, but it seems that the Thule at both Uivak and Cape Espenberg were heavily reliant on sedges.

Zutter (2009: 31) also observes that the tunnel at Uivak has macrofossils that probably represent the remnants of house sweepings that were not properly removed from the tunnel to be dumped in the nearby midden. One ethnographic report states that historic Inupiat women were especially fastidious housekeepers who would aggressively sweep any debris carried into the main living room, including snow, back into the tunnel (Thornton 1931). The variety of macrofossil taxa found in the tunnels at Cape Espenberg suggests a similar practice.

At both Uivak and Cape Espenberg, there is an abundance of plants that are both edible and medicinal (in green in Figures 5.1 and 5.2) at both sites in every context. More than half of the macrofossils in every context are comprised of plant taxa that are both edible and medicinal. The only context where edible plants do not constitute greater than 50% of the sample is on the sleeping platform at Uivak. This

is because of the abundance of non-edible plants with other uses – primarily taxa used for bedding (in red). Had the sleeping platforms specifically been separated from the living area contexts for analysis at Cape Espenberg like they were at Uivak, it is possible that the sleeping platforms of both houses may look relatively similar, with more macrofossils in the "other uses" category. The way the data is now, however, the context with the greatest amount of plants in the "other uses" category at Cape Espenberg appears to be the tunnel of Feature 68a.

Furthermore, there is the coprolite sample at Uivak to consider. The vast majority of macrofossils in this coprolite were berry seeds – mostly *Empetrum nigrum* and some *Vaccinium* sp. seeds (Zutter 2009: 29). There are, however, a small number of inedible plant taxa in the coprolite, as represented by the small red slice. The entrance of the Uivak house, however, contains only plants that are edible and medicinal. Why the entranceway of the Uivak site contains only edible macrofossil remains whereas the coprolite contains inedible macrofossil remains seems strange – why would a human coprolite contain a birch catkin, two spruce needles and three grasses, while the entrance sample contains none of these inedible specimens? Perhaps the coprolite has been contaminated with these inedible species.

At Uivak, there are many more macrofossils belonging to taxa without documented cultural uses – especially in the house floor context. At Cape Espenberg, each context has only a tiny percentage of plants without culturally documented uses, or none at all. Zutter classifies these taxa without documented uses as modern contaminants or weeds (2009: 28). For a list of these, see the "no known uses"

category in Table 5.3. It is possible that the Uivak site has more modern contamination than Cape Espenberg. Whether this contamination comes from depositional processes or from sediment sample recovery techniques is unknown. Furthermore, the Uivak site has no taxa that are strictly medicinal, or that are aquatic with no known cultural uses.

Finally, while the contexts at Uivak appear to be very different from one another, the different contexts at Cape Espenberg appear much more homogenous (see Figures 5.1 and 5.2). It is possible that this is a sampling issue. As seen in Chapter 4, some samples from Cape Espenberg were very different from other samples within the same context. With the addition of multiple samples from the same contexts, however, the Cape Espenberg contextual data normalized somewhat and the outliers did not dictate the overall pattern of a context. Since Zutter analyzed fewer samples from each context, and fewer samples overall, it is possible that the radical differences between contexts simply represent the collection of non-representative samples that would be considered outliers had more samples been collected. Certainly, the coprolite sample is one such outlier.

Despite being different sites in very different environments, there are some noticeable similarities between the Uivak site and the Cape Espenberg site. For one, the inhabitants of both sites seem to have taken advantage of many edible and medicinal plants on the landscape. Furthermore, the inhabitants of both sites utilized various plant taxa for bedding or insulation. It is difficult to gauge how heavily the inhabitants at Uivak relied on plants compared to the inhabitants of

Cape Espenberg, but it is clear that the Thule in these very different locales took advantage of many locally growing plant species.

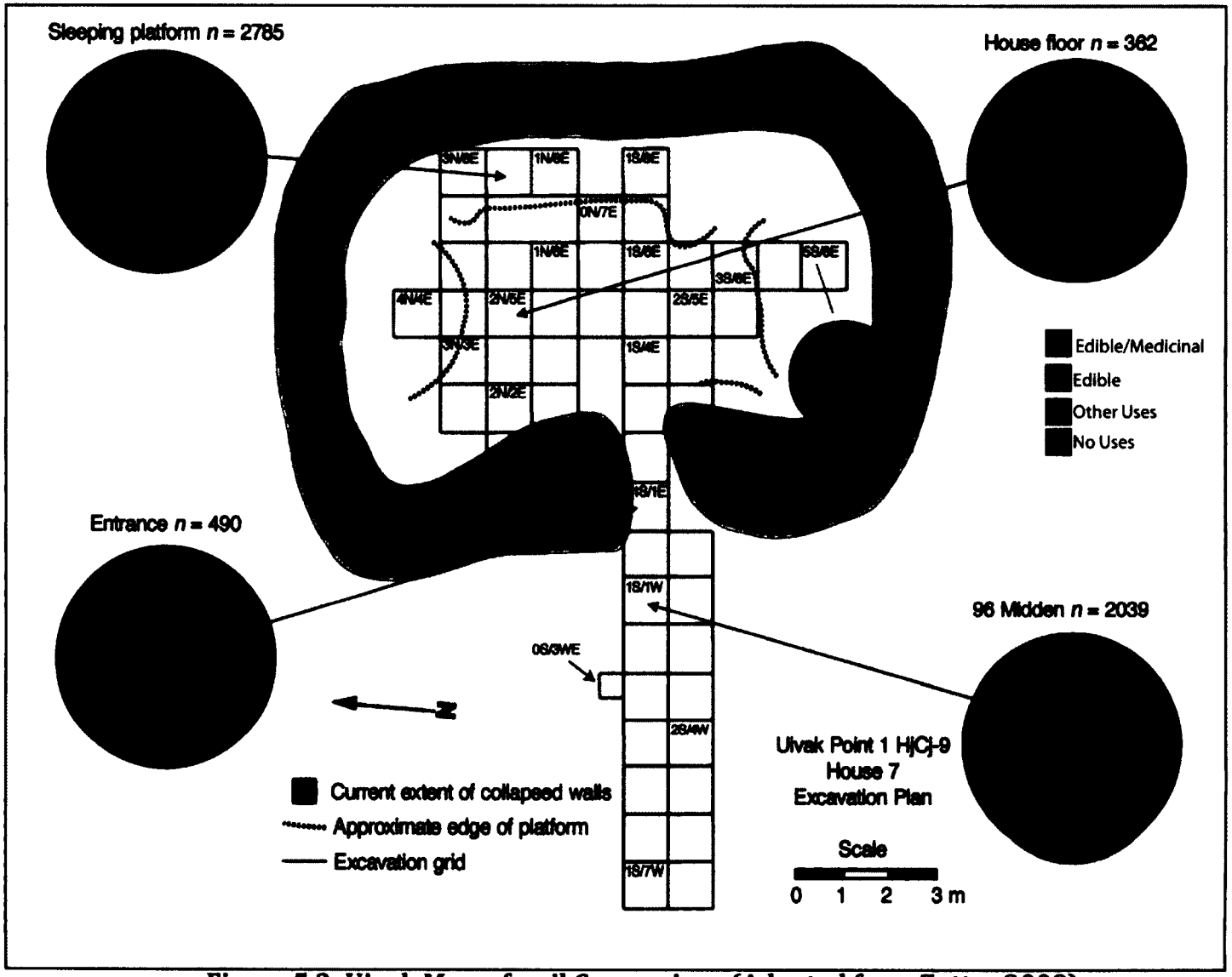


Figure 5.2: Uivak Macrofossil Comparison (Adapted from Zutter 2009).

Chapter 6: Conclusions

This thesis has demonstrated that the Thule at Cape Espenberg used many of the same plants and fuelwoods that their Inupiat descendents relied upon in historic and modern times. Crowberry and sedge remains dominated the macrofossil assemblage, and many of the other plant taxa recovered from cultural contexts have documented uses among the modern and historic Inupiat. Driftwood appears to have been the main source of woody fuel. Spruce – a non-local wood – was the most frequently recovered charcoal. Both shrubby willow and driftwood willow were burned in both houses. One surprise was that poplar, while used in the construction of Feature 33, was recovered in only very small amounts in charcoal form. Both charcoal and macrofossil data suggest that these houses were occupied during the winter and for at least part of the summer.

This data suggest that, while plant foods did not constitute the bulk of their diet, the Thule at Cape Espenberg still benefitted from consuming the many nutrients in plant foods that were largely lacking from their meat dominated diet. Furthermore, fuelwood appears to have been just as crucial as a resource to the Thule at Cape Espenberg as it is to modern people in Northwestern Alaska. At Cape Espenberg, driftwood fuel supplies seem to have been supplemented with local shrubby vegetation, blubber and possibly bone.

This thesis demonstrates that it is possible to study the use of a prehistoric Inuit site beyond the hunting of sea mammals. By studying plant and fuel use,

archaeologists can generate a fuller understanding of not only the Thule culture, but also other Neo-Eskimo and Paleo-Eskimo archaeological complexes across the Arctic as well. The study of macrofossil and charcoal remains allows archaeologists to study an entirely different and complimentary aspect of prehistoric Arctic subsistence practices. Moreover, this field of inquiry allows archaeologists to study largely unexplored aspects of prehistoric Arctic life.

Ultimately, this research is exploratory. The results of this thesis show that this type of research is valuable to Arctic archaeologists. With further research it may be possible to discover even more about prehistoric life. For one, with more sampling and better controls on context, studying plant and wood remains at prehistoric Arctic sites may be able to provide insight into gender roles, seasonality, and help identify activity areas within a site. Furthermore, future research may be able to delve deeper into behavioral ecology, and perhaps even help develop models for plant gathering optimization based on vitamin content, or simply improve on pre-existing models concerning fuel wood optimization. Future research would certainly benefit from an emphasis on developing optimization models for plant gathering.

From this thesis and Zutter's Uivak study, it appears that, even within contexts, samples are variable. In order to uncover the variability within contexts and houses, more samples should be taken. Ideally, blanket and column sampling should be employed. Comparisons between levels can help identify occupation levels that may otherwise be missed during the excavation process, and comparing

multiple samples from the same context can help uncover variability within a site. When matched with ethnographic data this information can provide valuable insight into the daily lives of prehistoric peoples.

Furthermore, more research needs to be done on the taphonomy of charcoal and macrofossil remains in Arctic sites. At this time, too little is known about what plants and what parts of a plant are most likely to preserve in an archaeological context, and why. This research is crucial because, at this point and time, it is unclear just how much taphonomic issues are influencing patterns seen in macrobotanical archaeological data.

Ideally, future research should involve excavating a historic era Inupiat house and a Thule era house to compare and contrast the differences found within each. In that way, archaeologists can get a firmer idea of what macrofossil remains look like in an Inupiat house where there exists firm ethnographic data, instead of just ethnographic analogy. In any case, more research will help contribute to this nascent field of study. Such a study can also help to shed light on issues of taphonomy by comparing the state of preservation in more recent contexts, to more ancient contexts.

Hopefully, this thesis will help to inspire future research, and encourage more archaeologists to view macrobotanical and anthracological studies as valuable subjects for research. It is neither time consuming or difficult to sample and float sediment samples in the field. Although the lab work is tedious and time consuming, the resulting data resolution is very fine. This venue of research can contribute to

many Arctic archaeological projects. By using robust sampling methods and making use of statistical tests, this sort of research should be valued equally as much as zooarchaeological and lithic studies, and can provide equally important data.

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Appendices

ANOVA and Tukey Post-Hoc Test Results: Macrofossil Results

Table A.1: ANOVA Comparing Macrofossil Abundance between Cultural, Fill and Off-Site Samples.

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	946736.69	2	473368.34	4.26	.019
Within Groups	6.328	57	111014.4		
Total	7.275	59			

Table A.2: Tukey Post-Hoc Test Comparing Macrofossil Abundance between Cultural, Fill and Off-Site Samples.

Tukey Post-Hoc Test						
Sample Type	Sample Type	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
[redacted]	Fill	-172.77	107.42	.25	-431.28	85.73
	[redacted]	-326.25	118.75	[redacted]	-612.01	-40.48
Fill	Cultural	172.77	107.42	.25	-85.73	431.28
	Off-Site	-153.47	140.14	.521	-490.72	183.77
Off-Site	[redacted]	326.25	118.75	[redacted]	40.48	612.01
	Fill	153.47	140.14	.521	-183.77	490.72

Table A.3: ANOVA comparing Macrofossils in Fill and Off-Site Samples.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Andromeda polifolia Leaves	Between Groups	.029	1	.029	.130	.722
	Within Groups	4.60	21	.219		
	Total	4.63	22			
Betula bract	Between Groups	.626	1	.626	2.398	.136
	Within Groups	5.48	21	.261		
	Total	6.11	22			
Carex	Between Groups	.168	1	.168	.153	.700
	Within Groups	23.13	21	1.102		
	Total	23.30	22			
Empetrum nigrum	Between Groups	8.49	1	8.492	.052	.822
	Within Groups	3449.38	21	164.256		
	Total	3457.87	22			
Equisetum stem joint fragments	Between Groups	.02	1	.020	.761	.393
	Within Groups	.554	21	.026		
	Total	.574	22			
Ericaceae bud scale	Between Groups	.020	1	.020	.761	.393
	Within Groups	.554	21	.026		
	Total	.574	22			
Hippuris seeds	Between Groups	.002	1	.002	.020	.889
	Within Groups	1.71	21	.082		
	Total	1.71	22			
Lathyrus maritimus seeds	Between Groups	.02	1	.020	.761	.393
	Within Groups	.554	21	.026		
	Total	.574	22			
Myriophyllum spicatum seeds	Between Groups	.008	1	.008	.761	.393
	Within Groups	.231	21	.011		
	Total	.239	22			
Poaceae	Between Groups	.013	1	.013	.761	.393
	Within Groups	.346	21	.016		
	Total	.359	22			
Polytrichum leaves	Between Groups	.150	1	.150	1.319	.264
	Within Groups	2.38	21	.113		
	Total	2.53	22			
Potamogeton	Between Groups	.151	1	.151	2.679	.117
	Within Groups	1.18	21	.056		
	Total	1.33	22			
Potentilla	Between Groups	4.79	1	4.795	2.960	**.100**
	Within Groups	34.01	21	1.620		
	Total	38.80	22			
Ranunculus seeds	Between Groups	.000	1	.000	.004	.949
	Within Groups	2.45	21	.117		
	Total	2.45	22			

Table A.3 continued

Salix/Potentilla leaves	Between Groups	.05	1	.050	1.319	.264
	Within Groups	.794	21	.038		
	Total	.844	22			
Salix	Between Groups	1.8	1	1.807	1.717	.204
	Within Groups	22.1	21	1.052		
	Total	23.9	22			
Salix/Vaccinium leaves	Between Groups	.05	1	.050	.761	.393
	Within Groups	1.38	21	.066		
	Total	1.43	22			
Unidentified	Between Groups	.09	1	.091	.809	.378
	Within Groups	2.36	21	.112		
	Total	2.45	22			
Vaccinium	Between Groups	.168	1	.168	.159	.694
	Within Groups	22.2	21	1.057		
	Total	22.37	22			

Table A.4: ANOVA comparing Macrofossils in Cultural samples and Off-Site Samples.

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Andromeda polifolia leaves	Between Groups	.043	1	.043	.324	.572
	Within Groups	5.95	45	.132		
	Total	6	46			
Apiaceae seeds	Between Groups	.001	1	.001	.266	.609
	Within Groups	.160	45	.004		
	Total	.161	46			
Arctostaphylos leaves	Between Groups	.010	1	.010	.531	.470
	Within Groups	.853	45	.019		
	Total	.863	46			
Artemisia leaves	Between Groups	.003	1	.003	.266	.609
	Within Groups	.486	45	.011		
	Total	.489	46			
Asteraceae seeds	Between Groups	.001	1	.001	.266	.609
	Within Groups	.146	45	.003		
	Total	.147	46			
***Betula* bract**	Between Groups	.873	1	.873	7.157	**.010**
	Within Groups	5.48	45	.122		
	Total	6.35	46			
Carex	Between Groups	.253	1	.253	.377	.542
	Within Groups	30.17	45	.671		
	Total	30.43	46			
Caryophyllaceae seed	Between Groups	.002	1	.002	.266	.609
	Within Groups	.292	45	.006		
	Total	.294	46			
Cerastium seeds	Between Groups	.001	1	.001	.266	.609
	Within Groups	.146	45	.003		
	Total	.147	46			
Empetrum nigrum	Between Groups	279.37	1	279.374	4.716	**.035**
	Within Groups	2665.97	45	59.244		
	Total	2945.34	46			
Eriophorum	Between Groups	.013	1	.013	.546	.464
	Within Groups	1.04	45	.023		
	Total	1.05	46			
Gramminoid	Between Groups	.001	1	.001	.266	.609
	Within Groups	.122	45	.003		
	Total	.122	46			
Hippuris seeds	Between Groups	.027	1	.027	.128	.723
	Within Groups	9.51	45	.211		
	Total	9.54	46			
Juncus seeds	Between Groups	.001	1	.001	.266	.609
	Within Groups	.243	45	.005		
	Total	.245	46			

Table A.4 continued

Lathyrus maritimus seeds	Between Groups	.002	1	.002	.266	.609
	Within Groups	.292	45	.006		
	Total	.294	46			
Ledum	Between Groups	.011	1	.011	.794	.378
	Within Groups	.641	45	.014		
	Total	.652	46			
Montia type seeds	Between Groups	.008	1	.008	.266	.609
	Within Groups	1.28	45	.029		
	Total	1.29	46			
Poaceae	Between Groups	.002	1	.002	.266	.609
	Within Groups	.417	45	.009		
	Total	.419	46			
Polygonum seeds	Between Groups	.007	1	.007	.266	.609
	Within Groups	1.21	45	.027		
	Total	1.22	46			
Potentilla	Between Groups	.239	1	.239	.957	.333
	Within Groups	11.25	45	.250		
	Total	11.49	46			
Ranunculus seeds	Between Groups	.049	1	.049	2.042	.160
	Within Groups	1.08	45	.024		
	Total	1.13	46			
Rosaceae seeds	Between Groups	.003	1	.003	.266	.609
	Within Groups	.584	45	.013		
	Total	.587	46			
Rubus chamaemorus seeds	Between Groups	.032	1	.032	.668	.418
	Within Groups	2.16	45	.048		
	Total	2.19	46			
Rumex seeds	Between Groups	.002	1	.002	.266	.609
	Within Groups	.292	45	.006		
	Total	.294	46			
Salix	Between Groups	.001	1	.001	.003	.957
	Within Groups	7.9	45	.176		
	Total	7.9	46			
Sparganium hyperboreum seeds	Between Groups	.004	1	.004	.266	.609
	Within Groups	.639	45	.014		
	Total	.642	46			
Unidentified	Between Groups	.003	1	.003	.009	.924
	Within Groups	16.58	45	.369		
	Total	16.58	46			
Vaccinium	Between Groups	.096	1	.096	.171	.681
	Within Groups	25.16	45	.559		
	Total	25.26	46			

Table A.5: ANOVA Comparing Macrofossils in Cultural and Fill Samples.

ANOVA		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Andromeda polifolia leaves	Between Groups	.057	1	.057	.746	.392
	Within Groups	3.64	48	.076		
	Total	3.70	49			
Apiaceae seeds	Between Groups	.001	1	.001	.347	.559
	Within Groups	.160	48	.003		
	Total	.162	49			
Arctostaphylos leaves	Between Groups	.019	1	.019	1.095	.301
	Within Groups	.846	48	.018		
	Total	.865	49			
Artemisia leaves	Between Groups	.004	1	.004	.347	.559
	Within Groups	.486	48	.010		
	Total	.490	49			
Asteraceae seeds	Between Groups	.001	1	.001	.347	.559
	Within Groups	.146	48	.003		
	Total	.147	49			
Carex	Between Groups	.984	1	.984	1.913	.173
	Within Groups	24.68	48	.514		
	Total	25.66	49			
Caryophyllaceae seeds	Between Groups	.002	1	.002	.347	.559
	Within Groups	.292	48	.006		
	Total	.294	49			
Cerastium Seeds	Between Groups	.001	1	.001	.347	.559
	Within Groups	.146	48	.003		
	Total	.147	49			
Empetrum nigrum	Between Groups	25.56	1	25.563	.796	.377
	Within Groups	1541.64	48	32.117		
	Total	1567.16	49			
Equisetum Stem Joint	Between Groups	.004	1	.004	.347	.559
	Within Groups	.584	48	.012		
	Total	.588	49			
Ericaceae bud scale	Between Groups	.004	1	.004	.347	.559
	Within Groups	.584	48	.012		
	Total	.588	49			
Eriophorum seeds	Between Groups	.015	1	.015	.712	.403
	Within Groups	1.04	48	.022		
	Total	1.05	49			
Gramminoid stems	Between Groups	.001	1	.001	.347	.559
	Within Groups	.122	48	.003		
	Total	.123	49			
Hippuris seeds	Between Groups	.152	1	.152	.764	.387
	Within Groups	9.54	48	.199		
	Total	9.70	49			

Table A.5 continued

Juncus seeds	Between Groups	.002	1	.002	.347	.559
	Within Groups	.243	48	.005		
	Total	.245	49			
Lathyrus maritimus seeds	Between Groups	.012	1	.012	.692	.410
	Within Groups	.853	48	.018		
	Total	.865	49			
Ledum	Between Groups	.014	1	.014	1.034	.314
	Within Groups	.641	48	.013		
	Total	.654	49			
Montia type seeds	Between Groups	.009	1	.009	.347	.559
	Within Groups	1.28	48	.027		
	Total	1.29	49			
Myriophyllum spicatum seeds	Between Groups	.002	1	.002	.347	.559
	Within Groups	.243	48	.005		
	Total	.245	49			
Poaceae	Between Groups	.011	1	.011	.712	.403
	Within Groups	.760	48	.016		
	Total	.771	49			
Polygonum seeds	Between Groups	.009	1	.009	.347	.559
	Within Groups	1.21	48	.025		
	Total	1.22	49			
Potamogeton seeds	Between Groups	.032	1	.032	1.081	.304
	Within Groups	1.41	48	.029		
	Total	1.44	49			
Potentilla	Between Groups	.085	1	.085	.096	.758
	Within Groups	42.61	48	.888		
	Total	42.69	49			
Ranunculus seeds	Between Groups	.025	1	.025	.601	.442
	Within Groups	2	48	.042		
	Total	2.02	49			
Rosaceae seeds	Between Groups	.004	1	.004	.347	.559
	Within Groups	.584	48	.012		
	Total	.588	49			
Rubus chamaemorus seeds	Between Groups	.002	1	.002	.041	.841
	Within Groups	2.19	48	.046		
	Total	2.20	49			
Rumex seeds	Between Groups	.002	1	.002	.347	.559
	Within Groups	.292	48	.006		
	Total	.294	49			
Salix	Between Groups	.000	1	.000	.000	.995
	Within Groups	28.67	48	.597		
	Total	28.67	49			
Salix/Vaccinium leaves	Between Groups	.011	1	.011	.347	.559
	Within Groups	1.45	48	.030		
	Total	1.47	49			

Table A.5 continued

Sparganium hyperboreum seeds	Between Groups	.005	1	.005	.347	.559
	Within Groups	.639	48	.013		
	Total	.643	49			
Unidentified	Between Groups	.139	1	.139	.667	.418
	Within Groups	10.00	48	.209		
	Total	10.14	49			
Vaccinium	Between Groups	.096	1	.096	.263	.610
	Within Groups	17.42	48	.363		
	Total	17.52	49			

Table A.6: ANOVA Comparing Macrofossils by Context in Feature 33.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
Andromeda polifolia leaves	Between Groups	.085	2	.042	1.23	.321
	Within Groups	.48	14	.034		
	Total	.565	16			
Arctostaphylos leaves	Between Groups	.032	2	.016	.906	.427
	Within Groups	.25	14	.018		
	Total	.282	16			
Carex	Between Groups	.02	2	.010	.028	.972
	Within Groups	5.014	14	.358		
	Total	5.034	16			
Caryophyllaceae seeds	Between Groups	.032	2	.016	.906	.427
	Within Groups	.25	14	.018		
	Total	.282	16			
Empetrum nigrum	Between Groups	5.79	2	2.899	1.51	.254
	Within Groups	26.78	14	1.913		
	Total	32.58	16			
Eriophorum seeds	Between Groups	.074	2	.037	.579	.573
	Within Groups	.897	14	.064		
	Total	.971	16			
Gramminoid stem	Between Groups	.013	2	.007	.906	.427
	Within Groups	.104	14	.007		
	Total	.118	16			
Hippuris seeds	Between Groups	.042	2	.021	1.235	.321
	Within Groups	.24	14	.017		
	Total	.282	16			
Juncus seeds	Between Groups	.027	2	.013	.906	.427
	Within Groups	.208	14	.015		
	Total	.235	16			
Lathyrus maritimus seeds	Between Groups	.042	2	.021	1.23	.321
	Within Groups	.24	14	.017		
	Total	.282	16			
Ledum	Between Groups	.032	2	.016	.906	.427
	Within Groups	.25	14	.018		
	Total	.282	16			
Polygonum seeds	Between Groups	.135	2	.067	.906	.427
	Within Groups	1.04	14	.074		
	Total	1.17	16			
[redacted]	Between Groups	.871	2	.436	4.48	[redacted]
	Within Groups	1.36	14	.097		
	Total	2.23	16			
Ranunculus seeds	Between Groups	.042	2	.021	1.23	.321
	Within Groups	.24	14	.017		
	Total	.282	16			

Table A.6 continued

Rosaceae seeds	Between Groups	.065	2	.032	.9	.427
	Within Groups	.5	14	.036		
	Total	.565	16			
Rumex seeds	Between Groups	.042	2	.021	1.23	.321
	Within Groups	.24	14	.017		
	Total	.282	16			
Salix	Between Groups	.226	2	.113	1.03	.381
	Within Groups	1.53	14	.109		
	Total	1.75	16			
Unidentified	Between Groups	.054	2	.027	.11	.897
	Within Groups	3.45	14	.246		
	Total	3.5	16			
Vaccinium	Between Groups	.516	2	.258	1.64	.228
	Within Groups	2.19	14	.157		
	Total	2.7	16			

Table A.7: Tukey Post-Hoc Test Comparing Macrofossils by Context in Feature 33.

[illegible]							
Andromeda polifolia leaves	Burnt Area	Tunnel	.0	.106	1	-.279	.279
		Living	-.154	.112	.376	-.448	.138
	Tunnel	Burnt Area	.0	.106	1	-.279	.279
		Living	-.154	.112	.376	-.448	.138
	Living	Burnt Area	.154	.112	.376	-.138	.448
		Tunnel	.154	.112	.376	-.138	.448
Arctostaphylos leaves	Burnt Area	Tunnel	-.091	.077	.482	-.293	.11
		Living	.0	.08	1	-.211	.211
	Tunnel	Burnt Area	.091	.077	.482	-.11	.293
		Living	.091	.08	.513	-.12	.303
	Living	Burnt Area	.0	.08	1	-.211	.211
		Tunnel	-.091	.08	.513	-.303	.12
Carex	Burnt Area	Tunnel	-.053	.345	.987	-.957	.85
		Living	-.083	.362	.971	-1.032	.864
	Tunnel	Burnt Area	.053	.345	.987	-.85	.957
		Living	-.03	.362	.996	-.978	.918
	Living	Burnt Area	.083	.362	.971	-.864	1.032
		Tunnel	.03	.362	.996	-.918	.978
Caryophyllaceae seeds	Burnt Area	Tunnel	.091	.077	.482	-.11	.293
		Living	.091	.08	.513	-.12	.303
	Tunnel	Burnt Area	-.091	.077	.482	-.29	.11
		Living	.0	.08	1	-.211	.211
	Living	Burnt Area	-.091	.08	.513	-.303	.12
		Tunnel	.0	.08	1	-.211	.211
Empetrum nigrum	Burnt Area	Tunnel	-1.386	.798	.227	-3.476	.703
		Living	-.605	.837	.754	-2.797	1.586
	Tunnel	Burnt Area	1.386	.798	.227	-.703	3.476
		Living	.781	.837	.629	-1.41	2.973
	Living	Burnt Area	.605	.837	.754	-1.586	2.797
		Tunnel	-.781	.837	.629	-2.973	1.41
Eriophorum seeds	Burnt Area	Tunnel	-.117	.146	.705	-.5	.264
		Living	-.154	.153	.582	-.556	.246
	Tunnel	Burnt Area	.117	.146	.705	-.264	.5
		Living	-.037	.153	.968	-.438	.364
	Living	Burnt Area	.154	.153	.582	-.246	.556
		Tunnel	.037	.153	.968	-.364	.438

Table A.7 continued

Gramminoid Stems	Burnt Area	Tunnel	-.058	.049	.482	-.189	.071
		Living	.0	.052	1	-.136	.136
	Tunnel	Burnt Area	.058	.049	.482	-.071	.189
		Living	.058	.052	.513	-.077	.195
	Living	Burnt Area	.0	.052	1	-.136	.136
		Tunnel	-.058	.052	.513	-.195	.077
Hippuris seeds	Burnt Area	Tunnel	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Tunnel	Burnt Area	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Living	Burnt Area	.109	.079	.376	-.098	.317
		Tunnel	.109	.079	.376	-.098	.317
Juncus seeds	Burnt Area	Tunnel	.083	.07	.482	-.101	.267
		Living	.083	.073	.513	-.11	.276
	Tunnel	Burnt Area	-.083	.07	.482	-.267	.101
		Living	.0	.073	1	-.193	.193
	Living	Burnt Area	-.083	.073	.513	-.276	.11
		Tunnel	.0	.073	1	-.193	.193
Lathyrus maritimus seeds	Burnt Area	Tunnel	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Tunnel	Burnt Area	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Living	Burnt Area	.109	.079	.376	-.098	.317
		Tunnel	.109	.079	.376	-.098	.317
Ledum	Burnt Area	Tunnel	-.091	.077	.482	-.293	.11
		Living	.0	.08	1	-.211	.211
	Tunnel	Burnt Area	.091	.077	.482	-.11	.293
		Living	.091	.08	.513	-.12	.303
	Living	Burnt Area	.0	.08	1	-.211	.211
		Tunnel	-.091	.08	.513	-.303	.12
Polygonum seeds	Burnt Area	Tunnel	-.186	.157	.482	-.598	.225
		Living	.0	.165	1	-.432	.432
	Tunnel	Burnt Area	.186	.157	.482	-.225	.598
		Living	.186	.165	.513	-.246	.618
	Living	Burnt Area	.0	.165	1	-.432	.432
		Tunnel	-.186	.165	.513	-.618	.246
[redacted]	[redacted]	[redacted]	-.504	.18	[redacted]	-.975	-.032
		Living	-.076	.189	.914	-.571	.418
	[redacted]	[redacted]	.504	.180	[redacted]	.032	.975
		[redacted]	.427	.189	[redacted]	-.067	.922
	[redacted]	Burnt Area	.076	.189	.914	-.418	.571
		[redacted]	-.427	.189	[redacted]	-.922	.067

Table A.7 continued

Ranunculus seeds	Burnt Area	Tunnel	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Tunnel	Burnt Area	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Living	Burnt Area	.109	.079	.376	-.098	.317
		Tunnel	.109	.079	.376	-.098	.317
Rosaceae seeds	Burnt Area	Tunnel	.129	.109	.482	-.156	.414
		Living	.129	.114	.513	-.17	.428
	Tunnel	Burnt Area	-.129	.109	.482	-.414	.156
		Living	.0	.114	1	-.299	.299
	Living	Burnt Area	-.129	.114	.513	-.428	.17
		Tunnel	.0	.114	1	-.299	.299
Rumex seeds	Burnt Area	Tunnel	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Tunnel	Burnt Area	.0	.075	1	-.197	.197
		Living	-.109	.079	.376	-.317	.098
	Living	Burnt Area	.109	.079	.376	-.098	.317
		Tunnel	.109	.079	.376	-.098	.317
Salix	Burnt Area	Tunnel	.273	.19	.351	-.225	.773
		Living	.118	.2	.825	-.405	.642
	Tunnel	Burnt Area	-.273	.19	.351	-.773	.225
		Living	-.154	.2	.725	-.678	.369
	Living	Burnt Area	-.118	.2	.825	-.642	.405
		Tunnel	.154	.2	.725	-.369	.678
Unidentified	Burnt Area	Tunnel	-.112	.286	.919	-.862	.637
		Living	-.124	.3	.911	-.911	.662
	Tunnel	Burnt Area	.112	.286	.919	-.637	.862
		Living	-.011	.3	.999	-.798	.774
	Living	Burnt Area	.124	.3	.911	-.662	.911
		Tunnel	.011	.3	.999	-.774	.798
Vaccinium	Burnt Area	Tunnel	-.249	.228	.535	-.847	.348
		Living	.180	.239	.736	-.446	.807
	Tunnel	Burnt Area	.249	.228	.535	-.348	.847
		Living	.43	.23	.207	-.196	1.057
	Living	Burnt Area	-.18	.239	.736	-.807	.446
		Tunnel	-.43	.239	.207	-1.057	.196

Table A.8: ANOVA Comparing Macrofossils by Context in Feature 68a.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
Andromeda polifolia leaves	Between Groups	.072	2	.036	.355	.706
	Within Groups	1.71	17	.101		
	Total	1.78	19			
Apiaceae seeds	Between Groups	.025	2	.012	1.59	.232
	Within Groups	.132	17	.008		
	Total	.157	19			
Arctostaphylos leaves	Between Groups	.056	2	.028	.921	.417
	Within Groups	.514	17	.03		
	Total	.570	19			
Artemisia leaves	Between Groups	.038	2	.019	.729	.497
	Within Groups	.438	17	.026		
	Total	.475	19			
Asteraceae seeds	Between Groups	.023	2	.011	1.59	.232
	Within Groups	.120	17	.007		
	Total	.143	19			
[redacted]	Between Groups	4.74	2	2.37	6.25	[redacted]
	Within Groups	6.45	17	.379		
	Total	11.19	19			
Cerastium seeds	Between Groups	.023	2	.011	1.5	.232
	Within Groups	.120	17	.007		
	Total	.143	19			
Empetrum nigrum	Between Groups	14.03	2	7.01	1.24	.314
	Within Groups	96.25	17	5.66		
	Total	110.29	19			
Hippuris seeds	Between Groups	.711	2	.355	.831	.453
	Within Groups	7.27	17	.428		
	Total	7.98	19			
[redacted]	Between Groups	.109	2	.055	3.75	[redacted]
	Within Groups	.248	17	.015		
	Total	.357	19			
Montia type seeds	Between Groups	.198	2	.099	1.59	.232
	Within Groups	1.05	17	.062		
	Total	1.25	19			
Poaceae	Between Groups	.064	2	.032	1.59	.232
	Within Groups	.343	17	.020		
	Total	.407	19			
Potentilla	Between Groups	.084	2	.042	.146	.865
	Within Groups	4.87	17	.287		
	Total	4.95	19			
Rubus chamaemorus seeds	Between Groups	.458	2	.229	2.47	.114
	Within Groups	1.57	17	.093		
	Total	2.03	19			

Table A.8 continued

Salix	Between Groups	.586	2	.293	1.6	.230
	Within Groups	3.1	17	.183		
	Total	3.69	19			
Sparganium hyperboreum seeds	Between Groups	.098	2	.049	1.59	.232
	Within Groups	.525	17	.031		
	Total	.623	19			
Unidentified	Between Groups	.088	2	.044	.153	.859
	Within Groups	4.87	17	.287		
	Total	4.96	19			
Vaccinium	Between Groups	.027	2	.013	.032	.969
	Within Groups	7.12	17	.419		
	Total	7.14	19			

Table A.9: Tukey Post-Hoc Test Comparing Macrofossils by Context in Feature 68a.

Andromeda polifolia leaves	Burnt Area	Tunnel	-.088	.185	.883	-.565	.388
		Living	.063	.164	.921	-.358	.485
	Tunnel	Burnt Area	.088	.185	.883	-.388	.565
		Living	.152	.181	.683	-.311	.616
	Living	Burnt Area	-.063	.164	.921	-.485	.358
		Tunnel	-.152	.181	.683	-.616	.311
Apiaceae seeds	Burnt Area	Tunnel	-.081	.051	.283	-.213	.051
		Living	.0	.045	1	-.116	.116
	Tunnel	Burnt Area	.081	.051	.283	-.051	.213
		Living	.081	.05	.266	-.047	.21
	Living	Burnt Area	.0	.045	1	-.116	.116
		Tunnel	-.081	.050	.266	-.21	.047
Arctostaphylos leaves	Burnt Area	Tunnel	.11	.101	.535	-.15	.371
		Living	.11	.09	.453	-.12	.341
	Tunnel	Burnt Area	-.11	.101	.535	-.371	.15
		Living	.0	.099	1	-.254	.254
	Living	Burnt Area	-.11	.09	.453	-.341	.12
		Tunnel	.0	.099	1	-.254	.254
Artemisia leaves	Burnt Area	Tunnel	.0	.093	1	-.241	.241
		Living	-.088	.083	.548	-.301	.124
	Tunnel	Burnt Area	.0	.093	1	-.241	.241
		Living	-.088	.091	.607	-.323	.146
	Living	Burnt Area	.088	.083	.548	-.124	.301
		Tunnel	.088	.091	.607	-.146	.323

Table A.9 continued

Asteraceae seeds	Burnt Area	Tunnel	-.077	.049	.283	-.203	.048
		Living	.0	.043	1	-.111	.111
	Tunnel	Burnt Area	.077	.049	.283	-.048	.203
		Living	.077	.047	.266	-.045	.2
	Living	Burnt Area	.0	.043	1	-.111	.111
		Tunnel	-.077	.047	.266	-.2	.045
[redacted]	[redacted]	[redacted]	-1.242	.360	[redacted]	-2.167	-.317
		[redacted]	-.744	.318	[redacted]	-1.562	.073
	[redacted]	[redacted]	1.242	.36	[redacted]	.317	2.167
		Living	.497	.351	.355	-.403	1.398
	[redacted]	[redacted]	.744	.318	[redacted]	-.073	1.562
		Tunnel	-.497	.351	.355	-1.398	.403
Cerastium seeds	Burnt Area	Tunnel	-.077	.049	.283	-.203	.048
		Living	.0	.043	1	-.111	.111
	Tunnel	Burnt Area	.077	.049	.283	-.048	.203
		Living	.077	.047	.266	-.045	.2
	Living	Burnt Area	.0	.043	1	-.111	.111
		Tunnel	-.077	.047	.266	-.2	.045
Empetrum nigrum	Burnt Area	Tunnel	1.962	1.393	.359	-1.611	5.537
		Living	1.581	1.231	.423	-1.577	4.741
	Tunnel	Burnt Area	-1.962	1.393	.359	-5.537	1.611
		Living	-.381	1.356	.958	-3.861	3.099
	Living	Burnt Area	-1.581	1.231	.423	-4.741	1.577
		Tunnel	.381	1.356	.958	-3.099	3.861
Hippuris seeds	Burnt Area	Tunnel	-.431	.383	.512	-1.414	.551
		Living	-.366	.338	.537	-1.235	.501
	Tunnel	Burnt Area	.431	.383	.512	-.551	1.414
		Living	.064	.372	.984	-.892	1.021
	Living	Burnt Area	.366	.338	.537	-.501	1.235
		Tunnel	-.064	.372	.984	-1.021	.892
[redacted]	[redacted]	[redacted]	-.17	.07	[redacted]	-.352	.01
		Living	.0	.062	1	-.16	.16
	[redacted]	[redacted]	.17	.07	[redacted]	-.01	.352
		[redacted]	.17	.068	[redacted]	-.005	.347
	[redacted]	Burnt Area	.0	.062	1	-.16	.16
		[redacted]	-.17	.068	[redacted]	-.347	.005
Montia type seeds	Burnt Area	Tunnel	-.229	.145	.283	-.603	.144
		Living	.0	.128	1	-.33	.33
	Tunnel	Burnt Area	.229	.145	.283	-.144	.603
		Living	.229	.142	.266	-.134	.594
	Living	Burnt Area	.0	.128	1	-.33	.33
		Tunnel	-.229	.142	.266	-.594	.134
Poaceae	Burnt Area	Tunnel	-.13	.083	.283	-.344	.082
		Living	.0	.073	1	-.188	.188
	Tunnel	Burnt Area	.13	.083	.283	-.082	.344
		Living	.13	.08	.266	-.076	.338
	Living	Burnt Area	.0	.073	1	-.188	.188
		Tunnel	-.13	.08	.266	-.338	.076

Table A.9 continued

Potentilla	Burnt Area	Tunnel	-.036	.313	.993	-.84	.767
		Living	-.144	.277	.862	-.855	.566
	Tunnel	Burnt Area	.036	.313	.993	-.767	.84
		Living	-.107	.305	.934	-.89	.675
	Living	Burnt Area	.144	.277	.862	-.566	.855
		Tunnel	.107	.305	.934	-.675	.89
Rubus chamaemorus seeds	Burnt Area	Tunnel	-.376	.178	.117	-.833	.08
		Living	-.06	.157	.923	-.464	.344
	Tunnel	Burnt Area	.376	.178	.117	-.08	.833
		Living	.316	.173	.192	-.128	.761
	Living	Burnt Area	.06	.157	.923	-.344	.464
		Tunnel	-.316	.173	.192	-.761	.128
Salix	Burnt Area	Tunnel	.358	.25	.347	-.283	1
		Living	-.06	.221	.960	-.628	.507
	Tunnel	Burnt Area	-.358	.25	.347	-1	.283
		Living	-.418	.243	.227	-1.044	.206
	Living	Burnt Area	.06	.221	.960	-.507	.628
		Tunnel	.418	.243	.227	-.206	1.044
Sparganium hyperboreum seeds	Burnt Area	Tunnel	-.162	.102	.283	-.426	.102
		Living	.0	.090	1	-.233	.233
	Tunnel	Burnt Area	.162	.102	.283	-.102	.426
		Living	.162	.1	.266	-.095	.419
	Living	Burnt Area	.0	.09	1	-.233	.233
		Tunnel	-.162	.1	.266	-.419	.095
Unidentified	Burnt Area	Tunnel	.151	.313	.881	-.653	.955
		Living	-.003	.277	1	-.714	.707
	Tunnel	Burnt Area	-.151	.313	.881	-.955	.653
		Living	-.154	.305	.869	-.937	.628
	Living	Burnt Area	.003	.277	1	-.707	.714
		Tunnel	.154	.305	.869	-.628	.937
Vaccinium	Burnt Area	Tunnel	.047	.378	.991	-.924	1.02
		Living	-.044	.334	.990	-.904	.814
	Tunnel	Burnt Area	-.047	.378	.991	-1.02	.924
		Living	-.092	.368	.966	-1.039	.853
	Living	Burnt Area	.044	.334	.990	-.814	.904
		Tunnel	.092	.368	.966	-.853	1.039

Table A.10: ANOVA Comparing F-68a-1 to F-33-1.

ANOVA		[illegible]	df	[illegible]	F	Sig.
Andromeda polifolia leaves	Between Groups	.115	1	.115	1.95	.19
	Within Groups	.650	11	.059		
	Total	.765	12			
Arctostaphylos leaves	Between Groups	.04	1	.04	.846	.377
	Within Groups	.514	11	.047		
	Total	.554	12			
Carex	Between Groups	.650	1	.65	2.27	.16
	Within Groups	3.14	11	.286		
	Total	3.79	12			
Caryophyllaceae	Between Groups	.027	1	.027	1.18	.3
	Within Groups	.250	11	.023		
	Total	.277	12			
Empetrum nigrum	Between Groups	14.13	1	14.134	1.64	.226
	Within Groups	94.48	11	8.589		
	Total	108.61	12			
Juncus seeds	Between Groups	.022	1	.022	1.18	.3
	Within Groups	.208	11	.019		
	Total	.231	12			
Potentilla	Between Groups	.179	1	.179	.663	.433
	Within Groups	2.96	11	.269		
	Total	3.14	12			
Rosaceae seeds	Between Groups	.054	1	.054	1.18	.3
	Within Groups	.5	11	.045		
	Total	.554	12			
Salix	Between Groups	.023	1	.023	.102	.755
	Within Groups	2.48	11	.226		
	Total	2.5	12			
Unidentified	Between Groups	.08	1	.08	.238	.635
	Within Groups	3.7	11	.337		
	Total	3.78	12			
Vaccinium	Between Groups	.009	1	.009	.022	.884
	Within Groups	4.25	11	.387		
	Total	4.26	12			

Table A.11: ANOVA Comparing Macrofossils in the Living areas of F. 68a and F. 33.

ANOVA						
Andromeda polifolia leaves	Between Groups	.003	1	.003	.035	.856
	Within Groups	.858	11	.078		
	Total	.861	12			
Artemisia leaves	Between Groups	.024	1	.024	.604	.453
	Within Groups	.438	11	.04		
	Total	.462	12			
Carex	Between Groups	.138	1	.138	.321	.582
	Within Groups	4.73	11	.431		
	Total	4.87	12			
Empetrum nigrum	Between Groups	.028	1	.028	.017	.9
	Within Groups	18.57	11	1.68		
	Total	18.6	12			
Eriophorum seeds	Between Groups	.074	1	.074	1.69	.22
	Within Groups	.480	11	.044		
	Total	.554	12			
Hippuris seeds	Between Groups	.204	1	.204	.434	.524
	Within Groups	5.16	11	.469		
	Total	5.36	12			
Lathyrus maritimus seeds	Between Groups	.037	1	.037	1.69	.22
	Within Groups	.240	11	.022		
	Total	.277	12			
Potentilla	Between Groups	.282	1	.282	1.63	.227
	Within Groups	1.89	11	.173		
	Total	2.18	12			
Ranunculus	Between Groups	.037	1	.037	1.69	.22
	Within Groups	.240	11	.022		
	Total	.277	12			
Rubus chamaemorus seeds	Between Groups	.011	1	.011	.604	.453
	Within Groups	.202	11	.018		
	Total	.213	12			
Rumex seeds	Between Groups	.037	1	.037	1.69	.22
	Within Groups	.24	11	.022		
	Total	.277	12			
Salix	Between Groups	.215	1	.215	1.09	.318
	Within Groups	2.15	11	.196		
	Total	2.36	12			
Unidentified	Between Groups	.004	1	.004	.028	.871
	Within Groups	1.65	11	.15		
	Total	1.65	12			
Vaccinium	Between Groups	.237	1	.237	.749	.405
	Within Groups	3.47	11	.316		
	Total	3.71	12			

Table A.12: ANOVA Comparing Macrofossils in the Tunnels of F. 68a and F. 33.

[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Andromeda polifolia leaves	Between Groups	.210	1	.21	2.76	.131
	Within Groups	.686	9	.076		
	Total	.896	10			
Apiaceae seeds	Between Groups	.018	1	.018	1.22	.297
	Within Groups	.132	9	.015		
	Total	.150	10			
Arctostaphylos leaves	Between Groups	.023	1	.023	.818	.389
	Within Groups	.250	9	.028		
	Total	.273	10			
Asteraceae seeds	Between Groups	.016	1	.016	1.22	.297
	Within Groups	.120	9	.013		
	Total	.136	10			
[redacted]	Between Groups	1.49	1	1.49	3.75	[redacted]
	Within Groups	3.58	9	.398		
	Total	5.07	10			
Cerastium seeds	Between Groups	.016	1	.016	1.22	.297
	Within Groups	.120	9	.013		
	Total	.136	10			
[redacted]	Between Groups	4.31	1	4.31	3.89	[redacted]
	Within Groups	9.983	9	1.1		
	Total	14.3	10			
Eriophorum seeds	Between Groups	.038	1	.038	.818	.389
	Within Groups	.417	9	.046		
	Total	.455	10			
Gramminoid stem	Between Groups	.009	1	.009	.818	.389
	Within Groups	.104	9	.012		
	Total	.114	10			
Hippuris seeds	Between Groups	.508	1	.508	1.94	.197
	Within Groups	2.35	9	.261		
	Total	2.85	10			
Ledum	Between Groups	.017	1	.017	.312	.59
	Within Groups	.498	9	.055		
	Total	.515	10			
Montia type seeds	Between Groups	.144	1	.144	1.22	.297
	Within Groups	1.05	9	.117		
	Total	1.19	10			
Poaceae	Between Groups	.047	1	.047	1.22	.297
	Within Groups	.343	9	.038		
	Total	.390	10			
Polygonum seeds	Between Groups	.095	1	.095	.818	.389
	Within Groups	1.04	9	.116		
	Total	1.13	10			

Table A. 12 continued

Potentilla	Between Groups	.147	1	.147	.964	.352
	Within Groups	1.37	9	.153		
	Total	1.52	10			
Rubus chamaemorus seeds	Between Groups	.387	1	.387	2.53	.146
	Within Groups	1.37	9	.153		
	Total	1.75	10			
Sparganium hyperboreum seeds	Between Groups	.072	1	.072	1.22	.297
	Within Groups	.525	9	.058		
	Total	.597	10			
Unidentified	Between Groups	.031	1	.031	.093	.767
	Within Groups	2.96	9	.329		
	Total	2.99	10			
Vaccinium	Between Groups	.164	1	.164	.934	.359
	Within Groups	1.58	9	.176		
	Total	1.74	10			

Anova and Tukey Post-Hoc Test Results: Charcoal Results

Table A.13: ANOVA Comparing Charcoal Sample Richness by Feature.

[redacted]					
Between Groups	2734.69	1	2734.69	.065	.8
Within Groups	1.42	34	42020.17		
Total	1.43	35			

Table A.14: ANOVA Comparing Charcoal Sample Richness by Context for both Features.

[redacted]					
Between Groups	275676.44	2	137838.22	3.93	[redacted]
Within Groups	1.15	33	35022.55		
Total	1.43	35			

Table A.15: Tukey Post-Hoc Test Comparing Charcoal Sample Richness by Context for both Features.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	184.73	73.4	[redacted]	4.61	364.85
	[redacted]	178.71	78.71	[redacted]	-14.43	371.87
[redacted]	[redacted]	-184.73	73.4	[redacted]	-364.85	-4.61
	Tunnel	-6.01	78.71	.997	-199.16	187.14
[redacted]	[redacted]	-178.71	78.71	[redacted]	-371.87	14.43
	Living	6.01	78.71	.997	-187.14	199.16

Table A.16: ANOVA comparing Angiosperm and Gymnosperm abundance by Feature.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
[redacted]	Between Groups	560.03	1	560.03	8.864	[redacted]
	Within Groups	2148.18	34	63.18		
	Total	2708.22	35			
Gymnosperm	Between Groups	.05	1	.05	.000	.985
	Within Groups	4825.9	34	141.94		
	Total	4826	35			
Undetermined	Between Groups	.235	1	.235	.086	.771
	Within Groups	92.73	34	2.72		
	Total	92.97	35			

Table A.17: ANOVA comparing Angiosperm and Gymnosperm abundance by Context.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
[redacted]	Between Groups	650.74	2	325.37	5.219	[redacted]
	Within Groups	2057.47	33	62.34		
	Total	2708.22	35			
[redacted]	Between Groups	629.96	2	314.98	2.477	[redacted]
	Within Groups	4196.03	33	127.15		
	Total	4826	35			
Undetermined	Between Groups	2.87	2	1.43	.526	.596
	Within Groups	90.1	33	2.73		
	Total	92.97	35			

Table A.18: Tukey Post-Hoc Test comparing Angiosperm and Gymnosperm abundance by Context.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	9.384	3.097	[redacted]	1.785	16.984
		[redacted]	7.984	3.321	[redacted]	-.165	16.134
	[redacted]	[redacted]	-9.384	3.097	[redacted]	-16.984	-1.785
		Tunnel	-1.4	3.321	.907	-9.549	6.749
	[redacted]	Burnt Area	-7.984	3.321	[redacted]	-16.134	.165
		Living	1.4	3.321	.907	-6.749	9.549
[redacted]	[redacted]	[redacted]	9.769	4.422	[redacted]	-1.083	20.622
		Tunnel	3.73	4.743	.714	-7.907	15.369
	[redacted]	[redacted]	-9.769	4.422	[redacted]	-20.622	1.083
		Tunnel	-6.038	4.743	.42	-17.676	5.599
	Tunnel	Burnt Area	-3.73	4.743	.714	-15.369	7.907
		Living	6.038	4.743	.42	-5.599	17.676
Undetermined	Burnt Area	Living	-.615	.648	.613	-2.205	.974
		Tunnel	-.069	.695	.995	-1.774	1.636
	Living	Burnt Area	.615	.648	.613	-.974	2.205
		Tunnel	.546	.695	.714	-1.159	2.251
	Tunnel	Burnt Area	.069	.695	.995	-1.636	1.774
		Living	-.546	.695	.714	-2.251	1.159

Table A.19: ANOVA comparing Angiosperm and Gymnosperm abundance by context in Feature 68a.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
[redacted]	Between Groups	152.95	2	76.47	3.07	[redacted]
	Within Groups	422.8	17	24.87		
	Total	575.75	19			
Gymnosperm	Between Groups	139.84	2	69.92	.545	.59
	Within Groups	2180.35	17	128.25		
	Total	2320.2	19			
Undetermined	Between Groups	2	2	1	.417	.666
	Within Groups	40.8	17	2.4		
	Total	42.8	19			

Table A.20: ANOVA comparing Angiosperm and Gymnosperm abundance by context in Feature 33.

ANOVA		[redacted]	df	[redacted]	F	[redacted]
[redacted]	Between Groups	553.9	2	276.95	3.53	[redacted]
	Within Groups	1018.53	13	78.34		
	Total	1572.43	15			
Gymnosperm	Between Groups	630.11	2	315.05	2.18	.152
	Within Groups	1875.63	13	144.27		
	Total	2505.75	15			
Undetermined	Between Groups	6.43	2	3.21	.96	.408
	Within Groups	43.5	13	3.34		
	Total	49.93	15			

Table A.21: ANOVA comparing Angiosperm and Gymnosperm abundance between F-68a-1 and F-33-1.

ANOVA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	Between Groups	439.74	1	439.74	7.33	[redacted]
	Within Groups	659.33	11	59.93		
	Total	1099.07	12			
Gymnosperm	Between Groups	28.61	1	28.61	.258	.622
	Within Groups	1221.69	11	111.06		
	Total	1250.3	12			
Undetermined	Between Groups	.8	1	.8	.323	.581
	Within Groups	27.5	11	2.5		
	Total	28.3	12			

Table A.22: ANOVA comparing Angiosperm and Gymnosperm abundance between the living areas of F. 68a and F. 33.

ANOVA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Angiosperm	Between Groups	46.8	1	46.8	1.29	.28
	Within Groups	399.2	11	36.29		
	Total	446	12			
Gymnosperm	Between Groups	108.93	1	108.93	.802	.39
	Within Groups	1494.3	11	135.84		
	Total	1603.23	12			
Undetermined	Between Groups	2.49	1	2.49	.879	.369
	Within Groups	31.2	11	2.83		
	Total	33.69	12			

Table A.23: ANOVA comparing Angiosperm and Gymnosperm abundance between the tunnels of F. 68a and F. 33.

ANOVA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Angiosperm	Between Groups	129.6	1	129.6	2.7	.138
	Within Groups	382.8	8	47.85		
	Total	512.4	9			
Gymnosperm	Between Groups	2.5	1	2.5	.015	.906
	Within Groups	1340	8	167.5		
	Total	1342.5	9			
Undetermined	Between Groups	2.5	1	2.5	.781	.403
	Within Groups	25.6	8	3.2		
	Total	28.1	9			

Table A.24: ANOVA comparing Charcoal taxa between Contexts in F. 68a.

	ANOVA	[illegible]	df	[illegible]	F	Sig.
Alnus	Between Groups	.371	2	.186	.921	.417
	Within Groups	3.42	17	.202		
	Total	3.8	19			
Angiosperm	Between Groups	1.01	2	.509	.118	.89
	Within Groups	73.53	17	4.32		
	Total	74.55	19			
Betula	Between Groups	.075	2	.038	.729	.497
	Within Groups	.875	17	.051		
	Total	.95	19			
Empetraceae	Between Groups	.6	2	.3	1.59	.232
	Within Groups	3.2	17	.188		
	Total	3.8	19			
Empetrum nigrum	Between Groups	.6	2	.3	1.59	.232
	Within Groups	3.2	17	.188		
	Total	3.8	19			
Gymnosperm	Between Groups	14.48	2	7.24	1.25	.312
	Within Groups	98.51	17	5.79		
	Total	113	19			
Picea/Larix c.f. Larix	Between Groups	280.44	2	140.22	1.11	.352
	Within Groups	2147.3	17	126.31		
	Total	2427.75	19			
Picea/Larix c.f Picea	Between Groups	2.27	2	1.13	.725	.499
	Within Groups	26.67	17	1.56		
	Total	28.95	19			
Populus	Between Groups	6.48	2	3.24	1.98	.167
	Within Groups	27.71	17	1.63		
	Total	34.2	19			
Populus/Salix	Between Groups	5.12	2	2.56	1.38	.277
	Within Groups	31.42	17	1.84		
	Total	36.55	19			
Salix	Between Groups	56.14	2	28.07	1.46	.259
	Within Groups	325.657	17	19.15		
	Total	381.8	19			
Undetermined	Between Groups	2	2	1	.417	.666
	Within Groups	40.8	17	2.4		
	Total	42.8	19			

Table A.25: ANOVA comparing Charcoal Taxa between Contexts in F. 33.

	ANOVA					
Angiosperm	Between Groups	31.2	2	15.6	.72	.505
	Within Groups	281.73	13	21.67		
	Total	312.93	15			
Betula	Between Groups	13.63	2	6.81	1.12	.354
	Within Groups	78.8	13	6.06		
	Total	92.43	15			
Empetraceae	Between Groups	8.43	2	4.21	1.99	.176
	Within Groups	27.5	13	2.11		
	Total	35.93	15			
Gymnosperm	Between Groups	3.43	2	1.71	.144	.868
	Within Groups	155.5	13	11.96		
	Total	158.93	15			
Picea	Between Groups	305.31	2	152.65	1.43	.274
	Within Groups	1386.43	13	106.64		
	Total	1691.75	15			
Picea/Larix c.f. *Picea*	Between Groups	49.3	2	24.65	1.7	.219
	Within Groups	187.63	13	14.43		
	Total	236.93	15			
Populus	Between Groups	6.1	2	3.05	.781	.478
	Within Groups	50.83	13	3.91		
	Total	56.93	15			
Populus/Salix	Between Groups	17.83	2	8.91	2.65	.108
	Within Groups	43.6	13	3.35		
	Total	61.43	15			
Salix	Between Groups	161.66	2	80.83	2.14	.156
	Within Groups	489.33	13	37.64		
	Total	651	15			
Undetermined	Between Groups	6.43	2	3.21	.962	.408
	Within Groups	43.5	13	3.34		
	Total	49.93	15			

Table A.26: ANOVA comparing charcoal taxa in F-68a-1 and F-33-1.

ANOVA		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Alnus	Between Groups	.264	1	.264	.846	.377
	Within Groups	3.42	11	.312		
	Total	3.69	12			
Angiosperm	Between Groups	46.88	1	46.88	1.96	.188
	Within Groups	262.19	11	23.83		
	Total	309.07	12			
Betula	Between Groups	12.92	1	12.92	1.82	.204
	Within Groups	78	11	7.09		
	Total	90.92	12			
Empetraceae	Between Groups	7.26	1	7.26	2.9	.116
	Within Groups	27.5	11	2.5		
	Total	34.76	12			
Gymnosperm	Between Groups	2.78	1	2.78	.343	.57
	Within Groups	89.21	11	8.11		
	Total	92	12			
Picea	Between Groups	14.5	1	14.5	.304	.592
	Within Groups	524.26	11	47.66		
	Total	538.76	12			
[redacted]	Between Groups	56.09	1	56.09	3.33	[redacted]
	Within Groups	184.83	11	16.8		
	Total	240.92	12			
Populus	Between Groups	5.14	1	5.14	2.3	.157
	Within Groups	24.54	11	2.23		
	Total	29.69	12			
Populus/Salix	Between Groups	1.64	1	1.64	.46	.512
	Within Groups	39.42	11	3.58		
	Total	41.07	12			
[redacted]	Between Groups	87.04	1	87.04	4.05	[redacted]
	Within Groups	236.19	11	21.47		
	Total	323.23	12			
Undetermined	Between Groups	.808	1	.808	.323	.581
	Within Groups	27.5	11	2.5		
	Total	28.3	12			

Table A.27: ANOVA comparing charcoal taxa in the living areas of F. 68a and F. 33.

ANOVA						
Angiosperm	Between Groups	12.61	1	12.61	2.94	.114
	Within Groups	47.07	11	4.28		
	Total	59.69	12			
Betula	Between Groups	.017	1	.017	.114	.742
	Within Groups	1.67	11	.152		
	Total	1.69	12			
Gymnosperm	Between Groups	13.56	1	13.56	1.67	.222
	Within Groups	89.2	11	8.1		
	Total	102.76	12			
Picea	Between Groups	36.09	1	36.09	.267	.616
	Within Groups	1486.67	11	135.15		
	Total	1522.76	12			
Picea/Larix c.f. *Picea*	Between Groups	.556	1	.556	.27	.614
	Within Groups	22.67	11	2.06		
	Total	23.23	12			
Populus	Between Groups	1.5	1	1.5	.987	.342
	Within Groups	16.8	11	1.52		
	Total	18.3	12			
Populus/Salix	Between Groups	.277	1	.277	.635	.443
	Within Groups	4.8	11	.436		
	Total	5.07	12			
Salix	Between Groups	6.03	1	6.03	.252	.626
	Within Groups	263.2	11	23.92		
	Total	269.23	12			
Undetermined	Between Groups	2.49	1	2.49	.879	.369
	Within Groups	31.2	11	2.83		
	Total	33.69	12			

Table A.28: ANOVA comparing charcoal taxa in the tunnels of F. 68a and F. 33.

[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Angiosperm	Between Groups	.9	1	.9	.157	.703
	Within Groups	46	8	5.75		
	Total	46.9	9			
Empetraceae	Between Groups	.4	1	.4	1	.347
	Within Groups	3.2	8	.4		
	Total	3.6	9			
Empetrum nigrum	Between Groups	.4	1	.4	1	.347
	Within Groups	3.2	8	.4		
	Total	3.6	9			
Gymnosperm	Between Groups	.0	1	.0	.0	1
	Within Groups	75.6	8	9.45		
	Total	75.6	9			
Picea	Between Groups	1.6	1	1.6	.008	.929
	Within Groups	1522.8	8	190.35		
	Total	1524.4	9			
Picea/Larix c.f. *Picea*	Between Groups	.1	1	.1	.118	.74
	Within Groups	6.8	8	.85		
	Total	6.9	9			
Populus	Between Groups	6.4	1	6.4	1.37	.274
	Within Groups	37.2	8	4.65		
	Total	43.6	9			
[redacted]	Between Groups	19.6	1	19.6	5.09	[redacted]
	Within Groups	30.8	8	3.85		
	Total	50.4	9			
Salix	Between Groups	22.5	1	22.5	.57	.472
	Within Groups	315.6	8	39.45		
	Total	338.1	9			
Undetermined	Between Groups	2.5	1	2.5	.781	.403
	Within Groups	25.6	8	3.2		
	Total	28.1	9			

Table A.29: ANOVA comparing Fatty Residue presence in F. 68a and F.33.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Between Groups	28.4	1	28.4	.176	.678
Within Groups	5489.23	34	161.44		
Total	5517.63	35			

Table A.30: ANOVA comparing Fatty Residue presence for contexts in both house features.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Between Groups	1152	2	576	4.354	[redacted]
Within Groups	4365.63	33	132.20		
Total	5517.63	35			

Table A.31: Tukey Post-Hoc Test comparing Fatty Residue presence for contexts in both house features.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	13.153	4.51	[redacted]	2.08	24.22
	Tunnel	8.52	4.83	.198	-3.34	20.39
[redacted]	[redacted]	-13.153	4.51	[redacted]	-24.22	-2.08
	Tunnel	-4.63	4.83	.609	-16.5	7.24
Tunnel	Burnt Area	-8.52	4.83	.198	-20.39	3.34
	Living	4.63	4.83	.609	-7.24	16.5

Table A.32: ANOVA comparing Fatty Residue presence between contexts in F. 68a.

Between Groups	879.08	2	439.54	2.684	
Within Groups	2783.71	17	163.74		
Total	3662.8	19			

Table A.33: ANOVA comparing Fatty Residue Presence between contexts in F. 33.

Between Groups	402	2	201	1.834	.199
Within Groups	1424.43	13	109.57		
Total	1826.43	15			

Table A.34: ANOVA comparing Fatty Residue Presence between F-68a-1 and F-33-1.

Between Groups	106.37	1	106.37	.863	.373
Within Groups	1356.54	11	123.32		
Total	1462.92	12			

Data Table A.35: ANOVA comparing Fatty Residue Presence between the living areas of F. 68a and F. 33

Between Groups	2.84	1	2.84	.02	.888
Within Groups	2241.6	16	140.1		
Total	2244.44	17			

Table A.36: ANOVA comparing Fatty Residue Presence between the tunnels of F. 68a and F. 33.

Between Groups	19.6	1	19.6	.161	.699
Within Groups	976.8	8	122.1		
Total	996.4	9			

Table A.37: ANOVA comparing growth curvature by context in F. 68a.

	ANOVA					
Not Twig	Between Groups	488.89	2	244.44	1.34	.287
	Within Groups	3092.05	17	181.88		
	Total	3580.95	19			
Twig	Between Groups	.24	2	.12	.38	.689
	Within Groups	5.5	17	.32		
	Total	5.75	19			
Unknown	Between Groups	5.44	2	2.72	.17	.839
	Within Groups	261.1	17	15.35		
	Total	266.55	19			

Table A.38: ANOVA comparing growth curvature by context in F. 33.

	ANOVA					
Not Twig	Between Groups	1520.53	2	760.26	2.94	
	Within Groups	3352.4	13	257.87		
	Total	4872.93	15			
Twig	Between Groups	43.4	2	21.7	1.87	.193
	Within Groups	150.53	13	11.57		
	Total	193.93	15			
Unknown	Between Groups	8.2	2	4.1	.16	.852
	Within Groups	327.73	13	25.21		
	Total	335.93	15			

Table A.39: Tukey Post-Hoc Test comparing growth curvature by context in F. 33.

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	23.6	9.72	[redacted]	-2.07	49.27
		Tunnel	11.4	9.72	.489	-14.27	37.07
	[redacted]	[redacted]	-23.6	9.72	[redacted]	-49.27	2.07
		Tunnel	-12.2	10.15	.473	-39.01	14.61
	Tunnel	Burnt Area	-11.4	9.72	.489	-37.07	14.27
		Living	12.2	10.15	.473	-14.61	39.01
Twig	Burnt Area	Living	3.66	2.06	.215	-1.77	9.1
		Tunnel	3.06	2.06	.328	-2.37	8.5
	Living	Burnt Area	-3.66	2.06	.215	-9.1	1.77
		Tunnel	-.6	2.15	.958	-6.28	5.08
	Tunnel	Burnt Area	-3.06	2.06	.328	-8.5	2.37
		Living	.6	2.15	.958	-5.08	6.28
Unknown	Burnt Area	Living	.73	3.04	.969	-7.29	8.7
		Tunnel	1.73	3.04	.838	-6.29	9.76
	Living	Burnt Area	-.73	3.04	.969	-8.76	7.29
		Tunnel	1	3.17	.947	-7.38	9.38
	Tunnel	Burnt Area	-1.73	3.04	.838	-9.76	6.29
		Living	-1	3.17	.947	-9.38	7.38

Table A.40: ANOVA comparing growth curvature between F-68a-1 and F-33-1.

[redacted]	ANOVA	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Not Twig	Between Groups	214.22	1	214.22	.99	.339
	Within Groups	2362.85	11	214.8		
	Total	2577.07	12			
[redacted]	Between Groups	62	1	62	5.29	[redacted]
	Within Groups	128.76	11	11.7		
	Total	190.76	12			
Unknown	Between Groups	22.16	1	22.16	.79	.393
	Within Groups	308.76	11	28.06		
	Total	330.92	12			

Table A.41: ANOVA comparing growth curvature between Living areas in F. 68a and F. 33.

	ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Not Twig	Between Groups	51.72	1	51.72	.19	.665
	Within Groups	2873.2	11	261.2		
	Total	2924.92	12			
[redacted]	Between Groups	2.35	1	2.35	9.01	[redacted]
	Within Groups	2.87	11	.26		
	Total	5.23	12			
Unknown	Between Groups	6.69	1	6.69	.44	.519
	Within Groups	166.07	11	15.09		
	Total	172.76	12			

Table A.42: ANOVA comparing growth curvature between Tunnels in F. 68a and F. 33.

	ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Not Twig	Between Groups	44.1	1	44.1	.292	.604
	Within Groups	1208.4	8	151.05		
	Total	1252.5	9			
Twig	Between Groups	3.6	1	3.6	1.18	.309
	Within Groups	24.6	8	3.05		
	Total	28	9			
Unknown	Between Groups	8.1	1	8.1	.568	.472
	Within Groups	114	8	14.25		
	Total	122.1	9			

Data Charts

Feature	Volume ml	Context	Unit	Level	*Arctostaphylos* leaves	*Betula* bract	*Empetrum nigrum* berries	*Empetrum nigrum* buds	*Empetrum nigrum* leaves	*Empetrum nigrum* seeds	*Empetrum nigrum* stems	*Ericaceae* bud scale	*Rosaceae* seeds	*Salix* buds	*Salix* bud scales	*Salix* leaves	*Salix* seed capsule	*Salix/Potentilla* leaves	*Salix/Vaccinium* leaves	*Vaccinium* berries	*Vaccinium* leaves	*Vaccinium* seeds	*Andromeda polifolia* leaves	*Aplaceae* seeds	*Artemisia* leaves	*Asteraceae* seeds	*Carex* Seeds	*Carex* seed coats	*Caryophyllaceae* seeds	*Cerastium* seeds	*Eriophorum* seeds	*Equisetum* stem	*Gramminoid* stem	*Poaceae* Seed	*Poaceae* seed holder	*Lathyrus maritimus* seeds	*Ledum* leaves	*Ledum* seeds	*Montia* type seeds	*Polygonum* seeds	*Potentilla* seeds	*Potentilla* leaves	*Potentilla* stem w/leaves	*Ranunculus* seeds	*Rubus chamaemorus* seeds	*Rumex* seeds	*Hippuris* seeds	*Juncus* seeds	*Myriophyllum spicatum* seeds	*Potamogeton* seeds	*Sparganium hyperboreum* seeds	*Polytrichum* leaves	Unidentified
33	500	Hearth	6N 2E	2A	0	0	0	0	7	7	0	0	2	0	0	0	0	0	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
33	600	Hearth	5N 3E	2A	0	0	0	0	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
33	500	Hearth	6N 3E	2B	0	0	0	0	2	18	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Hearth	6N 4E	2B	0	2	0	57	27	1	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	2000	Hearth	6N 3E	2C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Hearth	5N 1E	2E	0	0	0	21	19	2	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
33	650	Living	4N 1E	2A	0	0	0	11	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Living	2N 1E	2A	0	0	0	7	86	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Living	3N 2E	2A	0	0	0	7	9	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3
33	500	Living	4N 1E	2D	0	0	0	5	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0
33	500	Living	1N 1E	2D	0	0	0	6	32	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
33	750	Tunnel	7N 1E	2A	0	0	0	26	25	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
33	500	Tunnel	5N 4E	2D	0	0	1	40	20	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
33	500	Tunnel	7N 1E	2D	1	0	1	30	10	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
33	1200	Tunnel	5N 2E	2E	0	0	1	161	12	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	14	1	0	0	4	0	1	0	0	0	0	0	0	0	#	1	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Tunnel	5N 2E	2E	0	0	3	44	33	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
33	500	Tunnel	6N 2E	2E	0	0	0	16	6	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A.43: F68A Raw Cultural Macrofossil Count.

Feature	Volume ml	Context	Unit	Level	*Arctostaphylos* leaves	*Betula* bract	*Empetrum nigrum* berries	*Empetrum nigrum* buds	*Empetrum nigrum* leaves	*Empetrum nigrum* seeds	*Empetrum nigrum* stems	*Ericaceae* bud scale	*Rosaceae* seeds	*Salix* buds	*Salix* bud scales	*Salix* leaves	*Salix* seed capsule	*Salix/Potentilla* leaves	*Salix/Vaccinium* leaves	*Vaccinium* berries	*Vaccinium* leaves	*Vaccinium* seeds	*Andromeda polifolia* leaves	*Aplaceae* seeds	*Artemisia* leaves	*Asteraceae* seeds	*Carex* Seeds	*Carex* seed coats	*Caryophyllaceae* seeds	*Cerastium* seeds	*Eriophorum* seeds	*Equisetum* stem	*Gramminoid* stem	*Poaceae* Seed	*Poaceae* seed holder	*Lathyrus maritimus* seeds	*Ledum* leaves	*Ledum* seeds	*Montia* type seeds	*Polygonum* seeds	*Potentilla* seeds	*Potentilla* leaves	*Potentilla* stem w/leaves	*Ranunculus* seeds	*Rubus chamaemorus* seeds	*Rumex* seeds	*Hippuris* seeds	*Juncus* seeds	*Myriophyllum spicatum* seeds	*Potamogeton* seeds	*Sparganium hyperboreum* seeds	*Polytrichum* leaves	Unidentified
68a	500	Hearth	6N 3E	2A	0	0	0	0	8	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
68a	250	Hearth	4N 2E	2A	0	0	0	2	27	1	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	500	Hearth	5N 4E	2A	0	0	2	2	34	21	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	500	Hearth	6N 4E	2A	2	0	5	8	445	70	2	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	450	Hearth	6N 2E	2A	0	0	0	0	16	11	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	550	Hearth	5N 2E	2A	0	0	0	0	11	31	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	300	Hearth	7N 3E	2A	0	0	0	0	16	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
68a	500	Living	9N 2E	3C	0	0	0	0	5	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	450	Living	10N 3E	4A	0	0	0	0	20	8	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
68a	650	Living	11N 1E	4A	0	0	0	0	16	15	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
68a	292	Living	10N 1E	4A	0	0	0	9	20	25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	550	Living	11N 1E	4B	0	0	0	0	5	7	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
68a	500	Living	9N 1E	4B	0	0	0	0	9	12	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
68a	500	Living	10N 2E	4B	0	0	0	0	14	48	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	300	Living	9N 2E	4B	0	0	0	0	2	3	0	0	0	0	0	0	0	2	0	0	0	0	4	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	700	Tunnel	6N 5E	3C	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68a	1000	Tunnel	8N 4E	3D	0	0	0	0	30	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	13	0	0	1	0	0	0	0	0	0	1	1	0	0	4	0	0	0	2	0	1	0	0	0	0	0	0
68a	910	Tunnel	5N 5E	4A	0	0	0	0	16	63	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0
68a	350	Tunnel	9N 3E	4A	0	0	0	0	4	7	0	0	0	0	0	0	0	0	0	0	1	3	2	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
68a	1600	Tunnel	9N 3E	4D	0	0	0	4	98	63	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0

Table A.44: F33 Cultural Raw Macrofossil Count.

Feature	Volume ml	Context	Unit	Level	*Arctostaphylos* leaves	*Betula* bract	*Empetrum nigrum* berries	*Empetrum nigrum* buds	*Empetrum nigrum* leaves	*Empetrum nigrum* seeds	*Empetrum nigrum* stems	*Ericaceae* bud scale	*Rosaceae* seeds	*Salix* buds	*Salix* bud scales	*Salix* leaves	*Salix* seed capsule	*Salix/Potentilla* leaves	*Salix/Vaccinium* leaves	*Vaccinium* berries	*Vaccinium* leaves	*Vaccinium* seeds	*Andromeda polifolia* leaves	*Apiaceae* seeds	*Artemisia* leaves	*Asteraceae* seeds	*Carex* Seeds	*Carex* seed coats	*Caryophyllaceae* seeds	*Cerastium* seeds	*Eriophorum* seeds	*Equisetum* stem	*Gramminoid* stem	*Poaceae* Seed	*Poaceae* seed holder	*Lathyrus maritimus* seeds	*Ledum* leaves	*Ledum* seeds	*Montia* type seeds	*Polygonum* seeds	*Potentilla* seeds	*Potentilla* leaves	*Potentilla* stem w/leaves	*Ranunculus* seeds	*Rubus chamaemorus* seeds	*Rumex* seeds	*Hippuris* seeds	*Juncus* seeds	*Myriophyllum spicatum* seeds	*Potamogeton* seeds	*Sparganium hyperboreum* seeds	*Polytrichum* leaves	Unidentified
68A	250	Fill	9N 3E	1A	0	0	12	56	1516	126	14	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1
68A	150	Fill	5N 6E	1A	0	1	1	55	268	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68A	250	Fill	10N 1E	1A	0	0	3	1	56	103	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	400	Fill	5N 4E	1A	0	0	1	102	20	1	0	0	0	0	0	0	0	0	0	0	7	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
33	150	Fill	7N 1E	1A	0	0	2	75	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
33	500	Fill	9N 1E	1A	0	0	11	10	475	199	0	0	0	0	0	60	4	2	0	0	13	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1
33	450	Fill	10N 1E	1C	0	0	1	0	13	25	0	0	0	0	0	0	2	0	0	0	4	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	250	Fill	3N 5E	1A	0	0	10	13	457	113	1	1	0	0	3	3	1	0	0	0	6	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	1	0	0	0
21	200	Fill	4N 3E	1A	0	0	2	4	149	57	2	0	0	0	0	2	1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0
21	700	Fill	8N 5E	1B	0	0	1	6	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	300	Fill	9N 3E	1D	0	0	0	18	4	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
21	500	Fill	8N 3E	1D	0	0	0	19	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
21	600	Fill	8N 3E	2C	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A.45: Fill Samples Raw Macrofossil Count.

Feature	Volume ml	Context	Level	*Arctostaphylos* leaves	*Betula* bract	*Empetrum nigrum* berries	*Empetrum nigrum* buds	*Empetrum nigrum* leaves	*Empetrum nigrum* seeds	*Empetrum nigrum* stems	*Ericaceae* bud scale	*Rosaceae* seeds	*Salix* buds	*Salix* bud scales	*Salix* leaves	*Salix* seed capsule	*Salix/Potentilla* leaves	*Salix/Vaccinium* leaves	*Vaccinium* berries	*Vaccinium* leaves	*Vaccinium* seeds	*Andromeda polifolia* leaves	*Aplaceae* seeds	*Artemisia* leaves	*Asteraceae* seeds	*Carex* Seeds	*Carex* seed coats	*Caryophyllaceae* seeds	*Cerastium* seeds	*Eriophorum* seeds	*Equisetum* stem	*Gramminoid* stem	*Poaceae* Seed	*Poaceae* seed holder	*Lathyrus maritimus* seeds	*Ledum* leaves	*Ledum* seeds	*Montia* type seeds	*Polygonum* seeds	*Potentilla* seeds	*Potentilla* leaves	*Potentilla* stem w/leaves	*Ranunculus* seeds	*Rubus chamaemorus* seeds	*Rumex* seeds	*Hippuris* seeds	*Juncus* seeds	*Myriophyllum spicatum* seeds	*Potamogeton* seeds	*Sparganium hyperboreum* seeds	*Polytrichum* leaves	Unidentified
Pit 1	170	Off-Site	0-10	0	1	18	1	385	821	4	0	0	0	0	1	0	1	0	1	0	14	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	1	0	0	0	3	1
Pit 1	3100	Off-Site	10-20	0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 1	2720	Off-Site	20-30	0	0	0	0	3	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 1	3180	Off-Site	30-40	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 2	78.8	Off-Site	0-10	0	3	1	0	1092	97	1	0	0	0	0	1	0	0	0	0	3	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 2	2700	Off-Site	20-30	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 2	2800	Off-Site	110-120	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 3	82.9	Off-Site	43-45	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 4	138	Off-Site	18-22	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pit 5	1480	Off-Site	40-50	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A.46: Off-Site Samples Raw Macrofossil Count.

Table A.47: F68a Raw Charcoal Count.

Feature	Volume ml	Context	Unit	Level	*Alnus*	Angiosperm undiff.	*Betula*	*Empetraceae*	*Empetrum nigrum*	Gymnosperm undiff.	*Picea*	*Picea/Larix* cf. *Picea*	*Populus*	*Populus/Salix*	*Salix*	Undetermined
68A	500	Hearth	6N 3E	2A	0	5	0	0	0	1	30	0	0	0	12	2
68A	250	Hearth	4N 2E	2A	0	4	0	0	0	4	24	0	0	0	1	2
68A	500	Hearth	5N 4E	2A	2	5	0	0	0	3	29	0	0	1	8	2
68A	500	Hearth	6N 4E	2A	0	3	0	0	0	1	35	0	5	6	0	0
68A	450	Hearth	6N 2E	2A	0	0	0	0	0	0	38	0	3	1	8	0
68A	550	Hearth	5N 2E	2A	0	0	0	0	0	0	33	0	2	1	14	0
68A	300	Hearth	7N 3E	2A	0	3	0	0	0	2	37	0	0	0	7	1
68A	500	Living	9N 2E	3C	0	0	0	0	0	8	25	0	0	0	1	5
68A	292	Living	10N 1E	4A	0	4	0	0	0	0	37	5	1	2	0	1
68A	450	Living	10N 3E	4A	0	1	0	0	0	2	8	0	0	0	5	0
68A	650	Living	11N 1E	4A	0	4	0	0	0	7	23	0	2	1	11	2
68A	550	Living	11N 1E	4B	0	5	1	0	0	5	33	0	0	0	3	3
68A	500	Living	9N 1E	4B	0	5	0	0	0	5	6	0	0	0	1	0
68A	500	Living	10N 2E	4B	0	0	0	0	0	1	36	0	1	1	11	0
68A	300	Living	9N 2E	4B	0	0	0	0	0	0	21	0	0	0	0	1
68A	700	Tunnel	6N 5E	3C	0	5	0	2	0	3	17	2	0	0	4	3
68A	1000	Tunnel	8N 4E	3D	0	2	0	0	0	2	43	0	0	0	3	0
68A	910	Tunnel	5N 5E	4A	0	1	0	0	0	0	43	2	0	0	2	2
68A	350	Tunnel	9N 3E	4A	0	3	0	0	0	1	7	0	0	0	1	0
68A	1600	Tunnel	9N 3E	4D	0	3	0	0	2	5	30	0	0	0	6	4

Table A.48: F33 Raw Charcoal Count.

Feature	Volume ml	Context	Unit	Level	Angiosperm undiff.	*Betula*	*Empetraceae*	Gymnosperm undiff.	*Picea*	*Picea/Larix* cf. *Picea*	*Populus*	*Populus/Salix*	*Salix*	Undetermined
33	500	Hearth	6N 2E	2A	10	1	0	7	42	4	0	0	11	3
33	600	Hearth	5N 3E	2A	16	1	0	0	16	1	0	0	16	0
33	500	Hearth	6N 3E	2B	1	0	0	0	34	4	0	3	7	1
33	500	Hearth	6N 4E	2B	1	0	4	0	26	0	0	3	16	0
33	2000	Hearth	6N 3E	2C	12	10	0	8	31	16	0	3	15	5
33	500	Hearth	5N 1E	2E	0	0	5	0	32	0	1	3	9	0
33	650	Living	4N 1E	2A	4	0	0	0	10	0	0	0	7	4
33	500	Living	2N 1E	2A	5	1	0	0	35	0	4	1	1	3
33	500	Living	3N 2E	2A	5	0	0	0	29	0	2	0	14	0
33	500	Living	4N 1E	2D	6	0	0	5	16	0	0	0	3	3
33	500	Living	1N 1E	2D	2	0	0	2	11	1	0	0	2	2
33	750	Tunnel	7N 1E	2A	6	0	0	9	14	1	0	0	0	4
33	500	Tunnel	5N 4E	2D	0	0	0	0	43	1	1	5	0	0
33	500	Tunnel	7N 1E	2D	3	0	0	0	28	0	7	6	6	0
33	1200	Tunnel	5N 2E	2E	7	0	0	2	36	1	0	0	4	0
33	500	Tunnel	5N 2E	2E	1	0	0	0	23	2	0	3	21	0